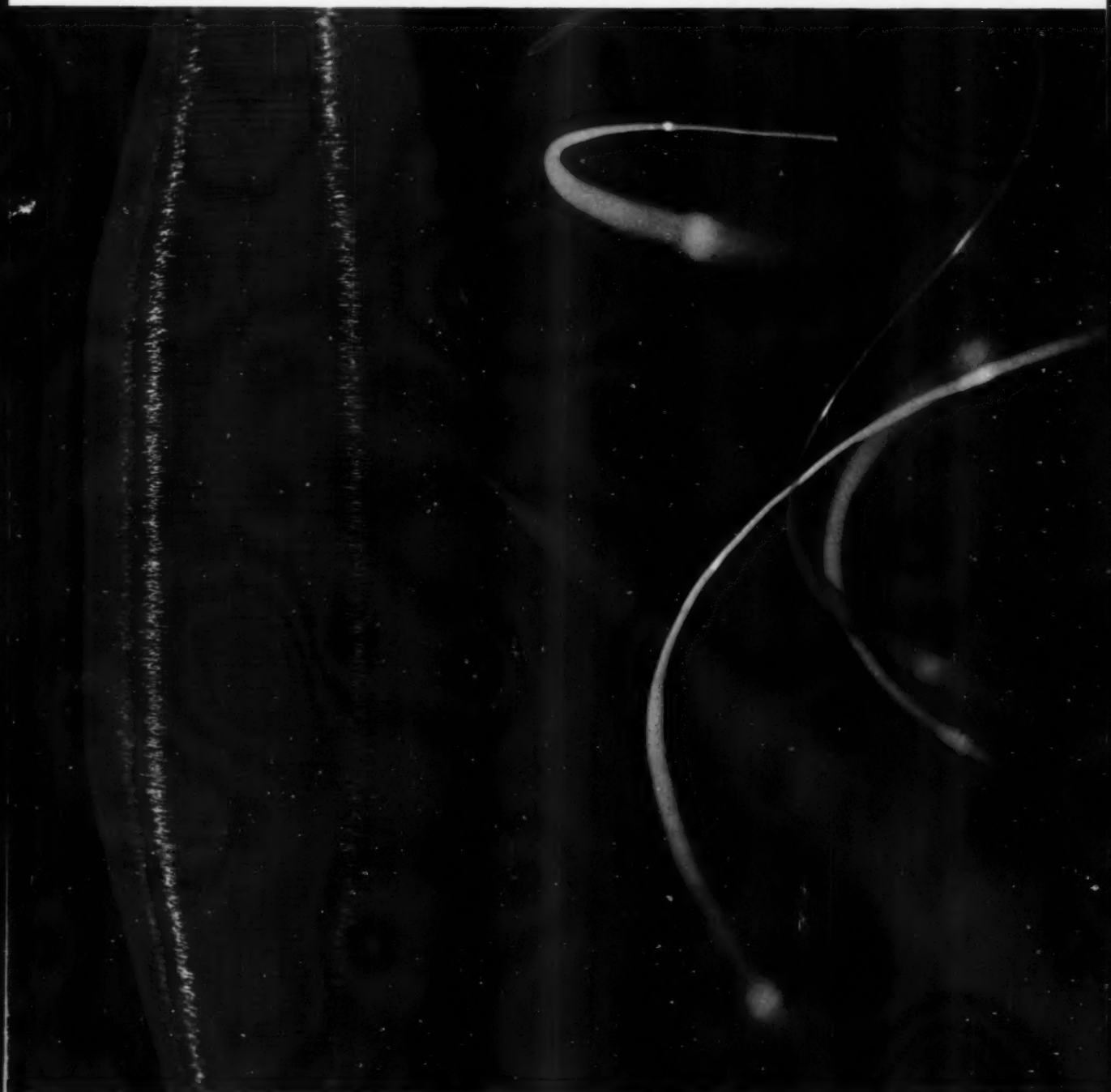
MODERN PLASTICS



DESIGNED AND PHOTOGRAPHED FOR MODERN PLASTICS BY RUDY MULLER

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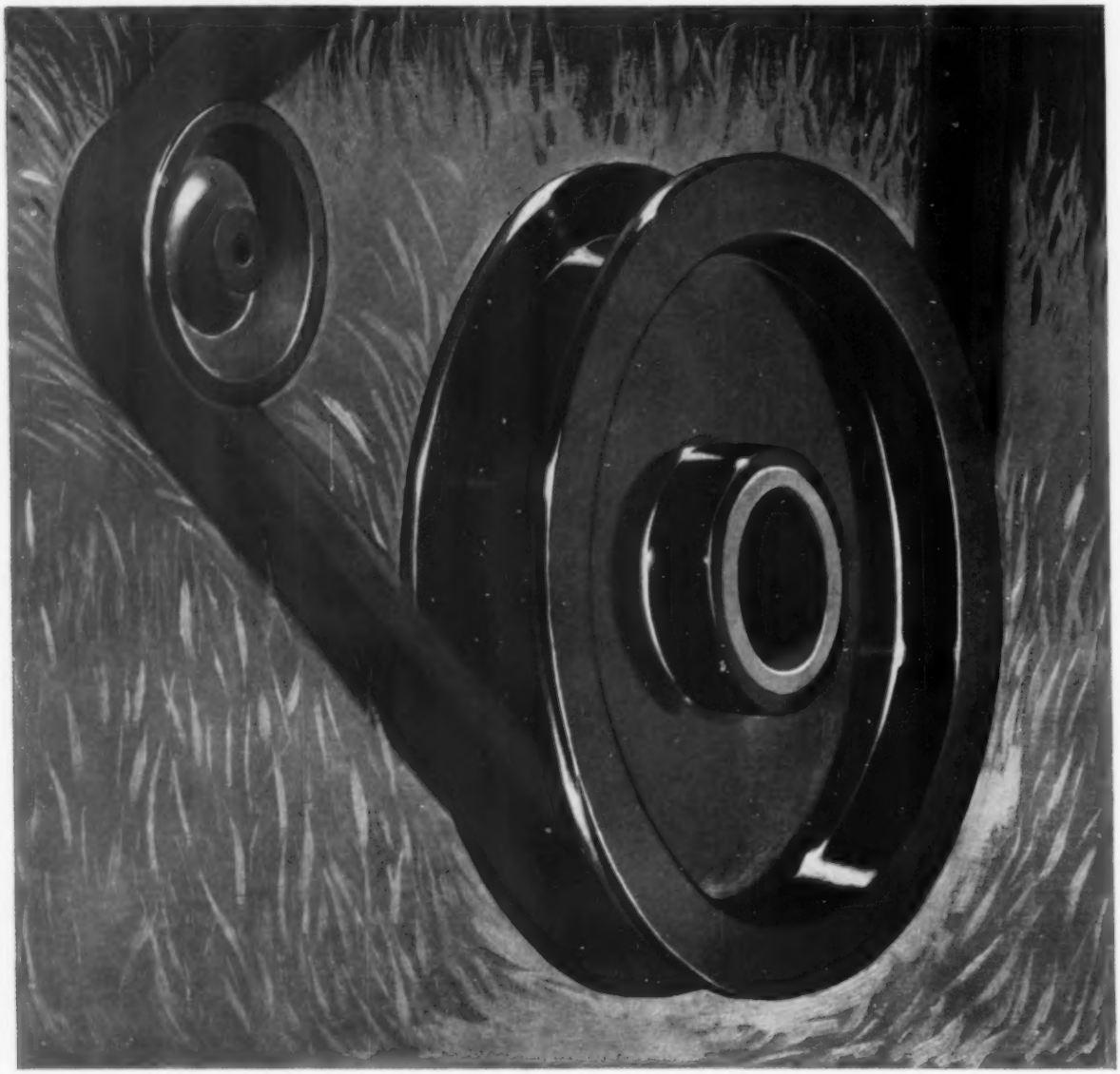
JUNE 1961

SPECIAL REPORT: The Plastics Show in New York ⟶

One of a series directed to IDEA-MEN



Keep things spinning–with phenolic

Ever think of molded phenolic for a *pulley?*

Lots of people are using it (in pulleys on lawn mowers, as an instance), and for different reasons. Light weight is one. Or savings on machining. You don't need to *balance* a phenolic pulley. In most cases there's no machining or special finishing of any kind.

With advantages like these, it's easy to see why power-appliance people are showing interest in today's phenolics as never before. These materials make up into rugged, durable, lightweight parts. One inexpensive Durez molding compound, for example, can deliver an izod impact strength of 1.2 ft.-lb./in. and tensile strength of 5500 psi. A pulley made of it runs true for years, stands up to 350°F heat and subzero cold, isn't affected by oil, water or other liquids, can't rust or pit, and stays smooth under the rubbing of a V-belt.

How do you translate all these advantages into selling points for *your* product? Your custom molder of phenolics will be glad to tell you.

Plan to see him soon. Also, to get better acquainted with today's phenolics and what they can do, send for our 16-page pocket guide, "Facts on Phenolics," which lets you compare the properties of many typical Durez molding compounds.

DUREZ PLASTICS DIVISION

HOOKER CHEMICAL CORPORATION, 1206 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICALS PLASTICS

Supplement to the MODERN PLASTICS June 1961 issue

Report on the N.Y. show

JUNE 5 to 9

MORE THAN 35,000 visitors jammed the three floors of the N. Y. Coliseum to view the offerings at the 9th National Plastics Exposition – and came away with a glowing picture of a healthy plastics industry expanding in every which direction. The over-all impression was one of quality – in faster, more diversified equipment, in improved materials, in top-flight products geared to the exacting demands of some of the toughest-to-crack markets in this country: automotive, building, electrical, missiles, packaging, and appliances. Some of the more obvious trends noted at the Exposition are capsuled below; details will follow in future issues of MODERN PLASTICS.

Machinery and equipment

Biggest splash in machinery made at the SPI Exposition was caused by the plunge of American injection machine manufacturers into the use of the extrusion screw for plastication and preplastication. Of course, the appearance of American reciprocating-screw injection machines at the show was not unexpected. But surprising is the completeness of the confidence in the superiority of this type of machine over the conventional injection machine as evidenced by the fact that such machines are now being made available by essentially every major domestic manufacturer.

There are differences in the manner in which manufacturers have adapted the screw extruder to their machines. Most of them have followed the lead of the European builders, using the screw in reciprocating fashion in a single cylinder where it acts as both a melt homogenizer and an injection ram. Other builders are using the screw extruder in place of a torpedo-type preplasticating cylinder to stuff a separate injection chamber equipped with a conventional ram, generally without a torpedo. Some offer the buyer the option of ordering a press with either arrangement; in either single- or double-stage fashion.

Basically, most of the screw injection units are similar in design. Shot capacities range from 6 to 30 oz.; a few are larger and most range around 14 to 20 ounces. Essentially all of the domestic machines use an hydraulic motor to drive the screw; most foreign designs use electric motors. In most cases the screw operates intermittently, being stopped on the injection stroke and depositing plasticated melt in the front of the injection cylinder on the cooling cycle.

As with any new development, there is certainly going to be controversy about the new equipment. Comments from some molders would indicate that they might go all the way for the new equipment. Other molders are not quite so sure that screw plastication will provide all the answers. Although almost everyone feels that the extrusion screw will do a better

job of plastication, especially with the stiffer-flowing materials, there are unanswered questions regarding the over-all operating costs of the new machines versus the conventional torpedo machine. Some molders seem to feel the new machines may be basically slower, but there seems to be no supporting data as yet either way. Being somewhat more complex than a conventional machine there are questions regarding the relative costs of maintenance. Although such equipment has been run extensively in Europe, few molders in this country have had a chance to play with such machines. There is also some question about the need for the more efficient plastication system when running easy-to-mold materials; there is some feeling that the conventional torpedo-type cylinder will be adequate for less critical materials. In any case, it seems certain the new machines will not completely replace the conventional machine overnight and that conventional torpedo machines will continue to be built for some time to come. Seemingly supporting evidence for this conclusion is the fact that injection machine builders are not swinging over their entire line to the screw-plastication injection system. In most cases, the machines are being offered in addition to the standard lines in a limited shot-capacity range. The coming months should shed a lot more light on the suitability of such machines.

Similar to the screw machines, in that a positive, rotating mixing device is used in the injection cylinder to homogenize the melt, was the rotating spreader machine being offered by one builder. Produced under license from the Du Pont Company, developer of the cylinder design, the rotating spreader has an annular piston operating over the shaft used to rotate the finned torpedo or spreader in the plasticating area. Plasticating efficiency is increased over the conventional stationary-type torpedo cylinder and the new design possesses advantages comparable to that of the screw machines. Like the screw machine, few have been in actual service and it is too early for an assessment of the success this design will enjoy.

In the extruder industry one cannot say that there was anything really new shown at the exposition. This is not meant to imply that constant improvements in extruders and auxiliary equipment are not being made. One trend noted was that toward compactness of equipment. Another trend is the offering of extruders specially adapted to the requirements of the specific processes, such as blow molding. Finer instrumentation is also an evident trend. Typical was a device for monitoring the thickness of extruded pipe based on measurement of dielectric properties of the pipe. Strides are also being made in the development of extrusion takeoff equipment. Notable was a pipe puller which made complete circumferential contact on the pipe. Among other advances in auxiliary extrusion equipment are the development of screen changers which eliminate costly down time, rotating dies for blown film which help produce flatter, more even rolls of film by averaging out gage variations, and commercially available underwater pelletizers.

In the extruder itself the emphasis is on designs offering higher horsepower and higher output. Easier disassembly is also featured to reduce costly maintenance down time. Increased flexibility in adapting the extruder to changing requirements is being offered by the use of interchangeble gears designed to alter the torque and horsepower of transmissions.

Similarly, although blow-molding equipment is being constantly improved and perfected – offering the molder a larger choice of equipment – it is hard to find equipment which is significantly different from that which has previously been available. The use of an accumulator for rapid parison extrusion is the pronounced trend and most equipment was either equipped with accumulators or could easily be adapted for their addition.

In connection with the production of hollow objects, made of polyethylene, a development to watch is the rotational casting of thermoplastic powders. It is too early to tell how the new equipment and techniques will compare with blow molding, but the development will bear watching.

Big trend in thermoforming equipment is the development of special machinery for specific applications. Much of the equipment seems aimed at the monster market of packaging. Automation and the combination of several operations into a single processing machine also seems to be the style. Same trend to automation is observed in compression-molding equipment.

Essentially new at show time are the ultrasonic sealing machines now being offered for the fabrication of plastic products made from film and sheet. Only three makes of machines were exhibited at the show although there are as many more companies also

offering such machines. Advantages of the new sealing machines are the ability to seal films that offer problems to dielectric equipment, ability to seal films without cleaning or pretreatment, ability to seal through the contents of a plastic film package, and the ability to seal heat-sensitive materials without the danger of decomposing the material. Current disadvantage is higher cost per inch of seal and the inability to do die or bar sealing; to get a linear seal the films must be pulled past a point sealing area.

Big news in the conventional RF-type sealing units is the announcement of units for the continuous production of heat-sealed sheet plastic products at rates up to 200 lb. per hour. In addition to making seals, other operations such as filling pouches, embossing, and decorating can be done in line with the sealing operation. Patents are pending on the equipment and the details were not given at the show.

Also relatively new at the show was automatic molding equipment for expandable polystyrene foams. Developed within the past year or so, such equipment appears to be headed for the packaging market where expandable polystyrene foams are creating a lot of excitement. Such systems include automated mold filling devices, cycling controls, and integral or separate facilities to supply the utilities of steam, water, air, and vacuum required for the process.

In the decoration of plastics, the key words are automation and increased production. New equipment designed to expose more area to the spray gun's output in a shorter time promises to increase painting rates to speeds up to ten times as fast as those previously possible. In general, marking and decorating equipment, along with other finishing equipment, is similar to that previously available but improved as regards its mechanical detail and efficiency.

Also in evidence at the show was bulk handling equipment, especially that of the pneumatic type. In connection with the handling of material, the development of mixing and proportioning hopper loaders and machine feeders designed for the blending of natural materials with color concentrates appears to offer significant advantages over the dry coloring process by eliminating preliminary blending operations.

Engineering materials take the play

As anticipated, the tough, new thermoplastics – ABS copolymers, acetal, high-impact acrylic, fluorocarbons, nylon, and polycarbonate – showed up in force. In contrast to the 1958 Exposition, when many of these materials were still experimental or under evaluation, booths at this 1961 show were loaded with actual commercial applications. Emphasis was on the use of these premium-priced plastics as replacements for metals in precision applications – and the results were obvious in the high level of sound engineering thinking that went into their design.

Automotive markets were a prime target. Instrument clusters showed up in acetal and ABS materials and one prototype model on display was molded of nylon-6 material. Metal-sheathed nylon cable, drive shaft cover and arm rests of ABS, and high-impact acrylic steering wheels were other typical applications.

Electrical and electronic applications, housings, tool handles, hardware, pump components, and bushings and bearings showed up in virtually all of these thermoplastics. Of considerable surprise was the size of some items: a 7.1-lb. acetal recirculating swimming pool pump; a 34-lb. molded fluorocarbon part for military use; and a freight car lining fabricated of ABS copolymer sheet backed up with styrene foam.

It was interesting to note too that blow molding – traditionally associated with polyolefins – was starting to reach for these new thermoplastics. Tough bottles

molded of acetal and of polycarbonate were on display, as was a hair dryer housing blow molded of high-impact acrylic.

Making their first appearance at a plastics show were urethane elastomers (in shoe heels, surgical gloves, cork tile surfacing) and the new vinylidene fluoride (in molded chemical process equipment).

Polyolefins, styrene, vinyl

The polyethylenes, of course, were more in evidence at the show than any other material — in a fantastic range of densities, melt indexes, homopolymers, copolymers, and blends. The housewares, toys, and laundry baskets that characterized polyethylene's previous appearances at these expositions were not as evident this year. Instead, high-density polyethylene was given much of the attention in such engineering applications as garden tools, industrial housings, automobile radiator caps, blow-molded automotive ducting, a molded milk carton box, a molded one-piece rigid beer bottle carrier (with integral hinge), and thermoformed boats.

Size of the polyethylene parts was also most impressive. Two of the newer processing techniques — blow molding and powder molding — were largely responsible. Blow-molded drums in capacities up to 55 gal. were to be seen and the powder-molded products included a 9-ft. sailboat, baby cribs, containers, and floor trucks.

Use of powdered polyethylene came in for considerable attention. One supplier had a rotational molding machine set up to turn out small basketballs and artificial fruit with the material; another had two artists on hand who utilized the colored powders to create "paintings" that could be fused into finished art work in a kitchen broiler.

Polypropylene applications similarly laid emphasis on some of its newer engineering uses, including molded chairs (largest one-shot molding to date) and luggage, backs for TV sets (already in use by most major manufacturers), pump components, laundry tubs (with molded-in scrubbing boards), and housings for electric shavers. The "built-in hinge" feature that has frequently shown up was emphasized in one supplier's booth with a line of one-piece hinges with molded-in screw holes.

In the styrenes, emphasis was on the impacts and the improved properties they offer. At one booth, this was demonstrated by an injection-molded high-impact styrene cup with walls only 1/32-in. thick supporting the full weight of a man. At another booth was a 10-lb. molded sink drain from Europe.

Improvements in vinyls, particularly the rigids and the improved high-temperature grades, were also evident. Emphasis here was on building applications. Products shown included: a kitchen sink liner thermoformed of high-temperature vinyl, rigid vinyl awnings, coated sidings, roof gutters, downspouts, Venetian blind slats, corrugated architectural siding, and coved counter edges.

Advances in thermosets

Polyesters and epoxies came in for a good deal of notice. Primarily, it was a case of refinements being made in formulations aimed at the markets that have been developing for the materials in the past few years. One of the newer products was an epoxy foam with good strength and shock-absorbing characteristics. Epoxy-terrazzo flooring tiles aroused interest, as did the appearance of parts molded of epoxy and exposed continuously to heat of 500° F.

The size and number of parts in polyester/glass were especially outstanding. Some of the more unusual products on display included a shell for a bicycle, a complete shower stall, a 130-lb. meat bin, a miniature model car, a 35-ft. sloop with one-piece hull, an aircraft radome, and numerous decorative architectural panels (one version used a hardboard panel surfaced with polyester-impregnated sheets in wood grains and colors). The undercurrent of talk, however, centered on possibilities for the two resins in products made by the filament-winding technique. With one exception (a filament-wound polyester/glass golf club shaft), most such parts on display were intended for military or industrial use; yet observers still felt that commercial applications of the technique were on the way. One epoxy resin supplier displayed a model of a filament-wound railroad tank car.

Most of the melamine and urea applications, while certainly upgraded in quality, had been seen before. The one exception was a light diffuser panel molded of a flame-resistant urea. Several refinements in formulations of phenolics were also announced and on display was an extruded phenolic which is expected to find application in market areas similar to those now served by paper-based phenolic laminates. Also shown were various missile parts molded of the so-called "exotic" phenolics reinforced with asbestos, quartz, graphite, etc. It seems logical to expect that someday soon, these ideas will be translated into commercial applications.

Among new uses for diallyl phthalate were low-cost decorative laminates. Some of the more recent electrical and electronic applications for the material were also on display, including a conductive DAP.

Plastics in many forms

Foamed plastics were one of the highlights of the show — with urethane foam and expandable styrene sharing the spotlight. Applications for the former included: insulation for refrigerators and coolers, garment interlining, cores for sandwiches, cushioning, and packaging. Most of the urethanes were of the one-shoe variety, including a new flame-retardant material. In expandable styrene, applications similarly ran the gamut from picnic coolers and packaging applications to water toys, boats, and cores for building panels. A new development: spaghetti-like strands of expandable styrene that can be expanded in a simple foamer into an extremely low-density, cushiony packaging medium.

Also new in foams was a microporous fluorocarbon — for use in filtration systems and as a separator in electrolytic cells — and a porous plastic produced from high-density PE to be used in air and liquid filtration, powder aeration pads, orthopedic splints, etc.

Films were numerous, with emphasis about evenly divided between packaging and industrial applications. One supplier demonstrated polyester bags filled with popcorn and placed under heat lamps to pop; another showed a model of the Echo satellite fabricated of polyester film. Among the newer films being discussed

were oriented cast polypropylene film, a vinylidene fluoride film up to 10 mils thick that can be oriented to provide tensiles up to 20,000 p.s.i., and nylon film with excellent heat stablity and toughness. Polycarbonate film also showed much potential. Of especial interest was a stamping machine for cold forming polycarbonate sheet.

Coatings were given a shot in the arm by a display devoted to the fluidized bed method. The resin being used was a special vinyl that used a dry-blend technique to prepare the powder for fluidizing (instead of hot compounding).

Advances in printed circuitry appeared at several booths, including a new polyester-glass laminate and a new copper-filled diallyl phthalate resin which could be used in making flush-printed circuits (the resin is filled into recesses in the molded board and pressed into place).

Mention should also be made of the many developments shown in the area of colorants for plastics, with emphasis on such special effects as metallics, pearlescents, and fluorescents. A large section of one display was also devoted to the variety of melamine and urea products (switch plates, handles, dishes) now being decorated by the molded-in foil overlay technique. Several observers also commented on the improvements in gel coats for imparting a smoother finish to reinforced plastics products. Cast acrylic sheets in metallic colors were introduced at the show.

S.P.I. 1961 Annual Conference

More than 1500 members of the plastics industry registered for the SPI 1961 Annual Conference, held in conjunction with the 9th Plastics Exposition. In several concurrent sessions on the mornings of June 6, 7, and 8, a total of 44 papers were read and discussed. Here are highlights from these papers.

Plastics in Communications

Moderator: J. V. McBride, *Plastics Wire & Cable Corp.*

On the recording arts: C. J. Martin, *Radio Corp. of America* – Some 50 to 70 million lb. of vinyl and polystyrene in use today for phonograph records. Styrene-acrylonitrile copolymers, vinyl copolymers, and low-molecular-weight vinyl homopolymers are being evaluated. Acetal, nylon, polypropylene, and polycarbonate are also possibilities – if and when prices drop. Compression molding cycles for vinyl records have been cut to 40 sec.; even faster cycling is in the offing.

On telephone communications: J. B. DeCoste and R. A. Connolly, *Bell Telephone Laboratories* – Use of plastics sheathing – polyethylene and PVC in particular – makes it possible to bury telephone wires directly in the ground without conduits. Successful completion of transatlantic telephone cable may promote use of plastics sheathing for similar types of installations.

On use in outer space: E. G. Linden, *U. S. Army Signal R & D Laboratory* – While plastics are already of value in space exploration, much still needs to be learned about their characteristics under conditions of high vacuum and radiation. Additives which may vaporize under vacuum must be avoided.

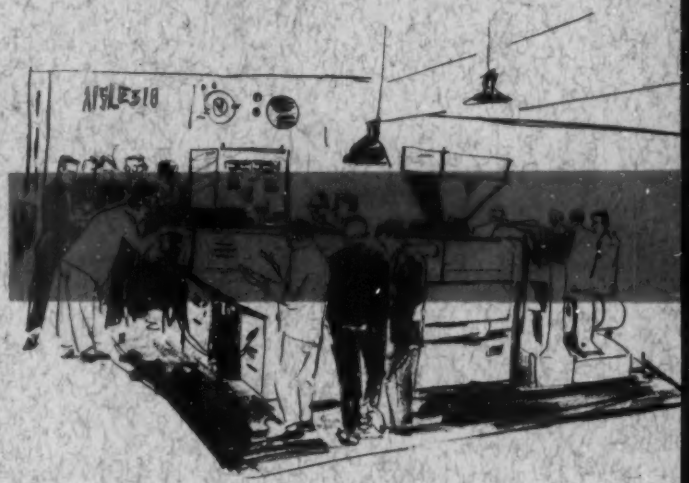
On radio, TV, and computor parts: I. Lampman and R. Shirk, *General Electric Co.* – In cabinets for radio and TV sets, customers now demand more texture, coloring, and styling innovations. A broader program of consumer education in plastics is also called for. And a growing market: plastics data tapes, wiring insulation, cabinets, and other components for computors.

Plastics in Building

Section I. Plastics Applications – *Moderator:* W. H. Scheick, *American Inst. of Architects.*

On architectural needs: George E. Danforth, *Ill. Inst. of Technology* – Exploration of structural frontiers today requires new materials to achieve new ends. But material suppliers and architects must remember that new materials and techniques have a meaning only in relation to how they serve today's needs.

On builders' needs: G. P. Dorrance, *Turner Construction Co.* – In general, builders have had much success with plastic building materials, although it is felt that more progress and/or experience is needed on such products as plastic bonding agents, underground piping, sandwich spandrel panels, and latex-terrazzo flooring. Builders need more assistance from material suppliers on flammability problems.



On service evaluation: W. Allen Cleneay, *Architect* – The incorporation of many new plastic building ideas in the construction of a large chemical research lab has afforded an excellent opportunity for evaluating in-use performance. Many early problems were traced to faulty installation techniques, now improved.

On plastics in lighting: Kirk M. Reid, *General Electric Co.* – Plastics role in lighting is not limited to direct use with light sources but, by providing light-colored finishes on walls, ceilings, floors, and furniture, can add brightness contrasts to a room. Much progress has been made in the flexibility, color, and brightness levels of plastic-coated electroluminescent lighting panels, and in over-all lighting efficiency by the use of contoured diffusers.

Section II. Codes – *Moderator:* Frank Ambrose, *Alsynite Div., Reichhold Chemicals Inc.*

On problems and opportunities: F. J. Rarig, *Rohm &*

Haas Co. – Two major problems that exist are the reluctance of plastic building material suppliers to recognize the legality of building codes, and the confusion often found in the writing of the codes. Commercial opportunities for plastics products are high, but education of public officials and the general public is needed.

On local code administration: Leo Goldstein, *City of Philadelphia* – Changes to local building codes take time, and immediate use of perfectly sound plastic products is not always possible. Manufacturers should anticipate code problems well in advance.

On code officials' needs: Paul E. Baseler, *Building Officials Conference of America Inc.* – All of the facts on properties of plastic building products must be presented to code officials for study, and given in a scientific manner. Product standards are desperately needed, rather than the measurement of individual company products as is common.

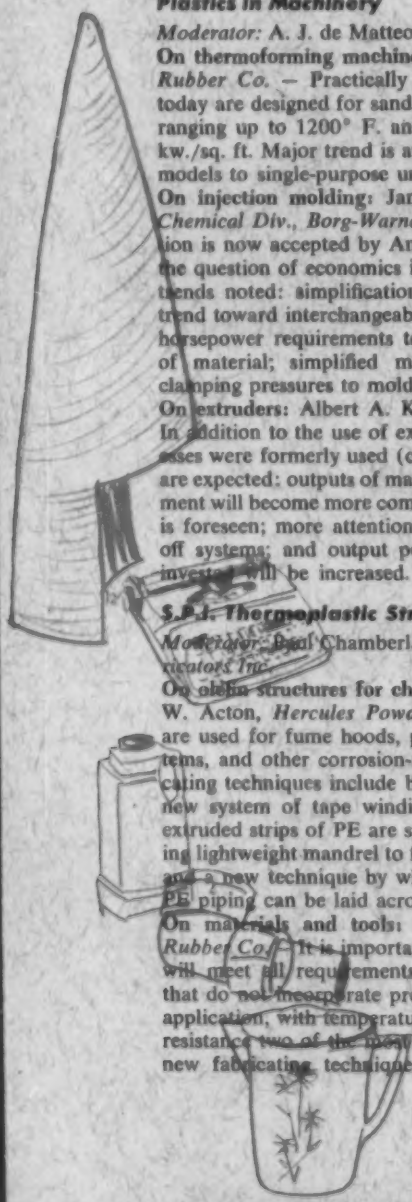
Plastics in Machinery

Moderator: A. J. de Matteo, *Consultant.*

On thermoforming machines: W. C. Schlager, *U. S. Rubber Co.* – Practically all machines being built today are designed for sandwich heating, with heaters ranging up to 1200° F. and average heat input at 2 kw./sq. ft. Major trend is away from general-purpose models to single-purpose units.

On injection molding: James W. Hendry, *Marbon Chemical Div., Borg-Warner Corp.* – Screw plastication is now accepted by American industry; however the question of economics is still up in the air. Other trends noted: simplification of injection system and trend toward interchangeability of parts; reduction in horsepower requirements to process a given volume of material; simplified maintenance; and reduced clamping pressures to mold large area pieces.

On extruders: Albert A. Kaufman, *Prodex Corp.* – In addition to the use of extruders where other processes were formerly used (calendering) several trends are expected: outputs of machines will increase; equipment will become more compact; finer instrumentation is foreseen; more attention will be focused on take-off systems; and output per horsepower and dollar invested will be increased.



S.P.I. Thermoplastic Structures Division

Moderator: Basil Chamberlain, *Industrial Plastic Fabricators Inc.*

On olefin structures for chemical industry: Dr. Paul W. Acton, *Hercules Powder Co.* – Thermoplastics are used for fume hoods, plating tanks, exhaust systems, and other corrosion-resistant structures. Fabricating techniques include butt and groove welding; a new system of tape winding in which continuously extruded strips of PE are spirally wound on a revolving lightweight mandrel to form cylindrical structures; and a new technique by which continuous lengths of PE piping can be laid across a river.

On materials and tools: Donald Wolff, *Seiberling Rubber Co.* – It is important to specify materials that will meet all requirements within given cost limits, that do not incorporate properties not needed for an application, with temperature resistance and chemical resistance two of the most important factors. Among new fabricating techniques cited were gun tacking (tip of welding gun is used to tack adjacent sheets in position until final seams are made) and welding equipment with self-feeding tip that can raise welding production rate to as high as 48 in./min.

On fabricating plastics for corrosion control: Alfred B. del'Etoile, *Delbrook Engineering Inc.* In switching from metal to PVC fabrication for corrosive service applications, company found that it could use many of its previous machines. The new equipment required was an oven for 4- by 8-ft. sheet, compressed-air piping, and saws. Over-all cost of a ventilating system fabricated of PVC was estimated at from 50 to 60% that of a galvanized steel system.

Plastics in Packaging

Moderator: Lloyd Stouffer, *Ed. "Modern Packaging"*

On future markets: D. R. Mahaney, *Monsanto Chemical Co.* – By 1965, plastics volume will surpass $800 million in packaging industry; its share of the market will double from 4.2 to over 8 percent. Major growth areas will be in flexible films (particularly as overwrap for produce, bakery products, and soft goods), rigid packaging, blown bottles, and coating or laminating of conventional materials. Estimates for 1965: 540 million lb. of plastic film, 513 million lb. of plastics for rigid containers.

On flexible films: F. E. Long, *Continental Can Co.* – Frontier for development is improving film permeability through laminates, coatings (*e.g.*, polymer-coated cellophane, polyvinylidene chloride-coated polyethylene, etc.), metallizing (can reduce permeability by ⅛ or more), irradiation, or orientation. New films to watch: nylons, polyesters, foamed styrenes, fluorocarbons, water-solubles (PVA, carboxy-methyl cellulose, PE oxide).

On bottles and tubes: A. J. Sanders, *Colgate-Palmolive Co.* – Company's laboratory devotes 50% of its time to developing plastics applications. Current uses: closures, PE-laminated cartons, blow-molded containers. Merchandising appeal is prime reason for use; lower total costs (material and processing) needed to expand markets even further.

On nestable containers: F. N. Hartmann, *Lily-Tulip Cup Corp.* – Improvements noted in four major categories: injection-molded containers using improved materials (*e.g.*, impact styrenes) and made with thinner walls, lower in cost; thermoformed containers also using tough new materials, are more uniform; plastic-coated and extrusion-laminated paperboard containers now manufactured at high speeds.

Plastics in Automotive

Moderator: H. Barclay, *"Automotive Industries"*

On uses and requirements: T. H. Risk and J. R. Forrester, Jr., *Ford Motor Co.* – About 25 lb. of plastic in use in average car today; estimates are for 45 lb. per car by 1965. Tough, new plastics (with emphasis on thermoplastics), declining cost curves, and better understanding of plastics properties are major reasons for growth. Although only 30% of plastics used to date have been for functional parts, emphasis is now switching (*e.g.*, arm rests, seat shields, kick panels). To expand markets further, improvements needed in heat resistance, stress resistance, and low-temperature performance.

On the cost picture: J. D. Moran, *Chrysler Corp.*–

Automotive engineers are finding new ways to cut costs by reducing finishing costs, by simplifying assembly. Two examples from Chrysler: a one-piece plastic bezel replaces a three-piece metal-and-glass assembly; a one-piece glass-alkyd brush holder plate replaces an assembly of 27 parts! Faster and cheaper tooling and programming also figure in the cost.

On the role of the processor: J. J. O'Connell, *Consolidated Molded Products Corp.* – To retain his share of the market, the custom processor must specialize – whether it be in material, type of part, or processing – so that he can offer engineering know-how to give him a competitive edge over the captive plant. More quality control, better adherence to standards, fixed delivery date, and development of new auto applications by the custom processor are also of importance.

On future markets: Dr. J. Young, *E. I. du Pont de Nemours & Co. Inc.* – Inherent advantages of lighter weight, economics, and design flexibility will see plastics move more and more into such areas as: foamed-in-place upholstery; one-piece consoles incorporating receptacles with molded-in hinges; chassis components; automobile bodies; fuel systems (*i.e.*, carburetors and gas tanks); blow-molded trunk linings and fluid tanks. Conductive plastics in the works are of much interest.

S.P.I. Vinyl Dispersion Division

Moderator: Frank W. Caplan, *Reynolds Chemical Products Co.*

On growth: Robert T. Henson, *Flexible Products Co.* – The industry will have grown from 25 million lb. of resin production in 1952 to 125 million lb. by 1962, going into such markets as toys, textiles, construction, transportation, surgical, packaging, sports, electrical equipment, fabricated metal, etc.

What they are: Donald R. Meserve, *Metal & Thermit Corp.* – They are suspensions of resin in non-aqueous liquids that don't dissolve it at room temperature. If liquid phase is plasticizer, they are called plastisols; if it contains volatiles, they're known as organosols. Methods of application include casting, dip coating, slush molding, rotational casting, cavity molding, flow coating, extrusion, and spray coating.

On custom formulator: Robert F. McTague, *The Stanley Chemical Co.* – He provides experienced dispersion lab., reduced and simplified inventory for customer, savings in capital investment, marketing assistance, etc. If customer, after having bought from formulator, wants to do own formulating, Mr. McTague proposes a development contract that specifies when formulator turns over manufacturing technique and know-how to customer, and at what price.

S.P.I. Epoxy Resin Formulators Division

Moderator: Donald Roon, *Hysol Corp.*

On epoxy adhesives: Bernard Gould, *Rubber & Asbestos Corp.* – Too much fanciful emphasis is placed on the future of epoxy adhesives, rather than on current valid production usages. There is available today a dry film form of epoxy adhesive that eliminates all problems of epoxy liquid or paste handling.

On epoxies as electrical insulation: John Delmonte, *Furane Plastics Inc.* – There are few materials that can match epoxies as solid dielectrics. They offer good mechanical qualities, can meet unusual design requirements. New trends in epoxies for electrical uses: flame-resistant compounds; molding compounds; one-component systems; epoxy foams; resilient epoxies; and fluidized bed coatings.

On epoxy tooling: Charles V. Douglas, Jr., *The Marblette Corp.* – Epoxies account for 95% of all plastics used for tooling. Savings due to the simpler and faster fabrication of epoxy tools are more signficant than savings in materials costs.

On miscellaneous epoxy applications: Cecil W. Armstrong, *Armstrong Products Co.* – Among the recent new applications for epoxy resins have been non-skid surface coatings on flooring, filament-wound products using epoxy binders, foam-in-place epoxies, cast trans-

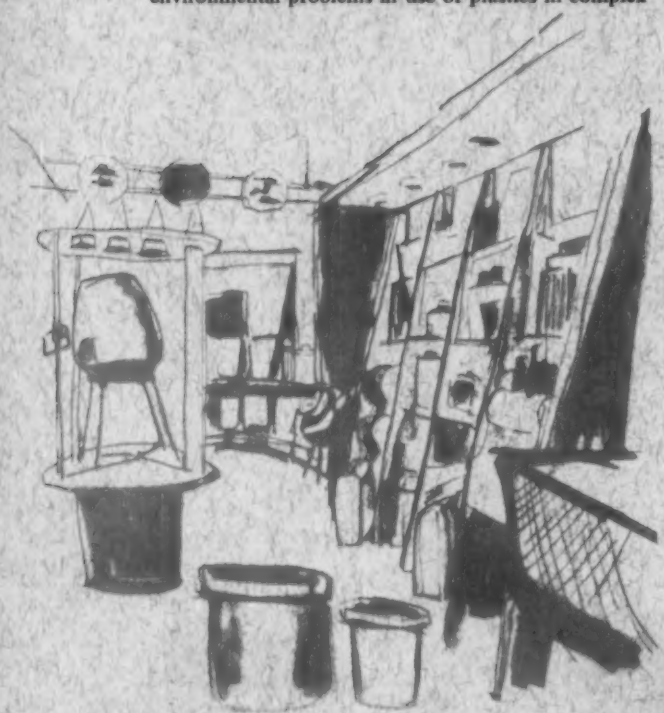
lucent epoxy products for stress testing, planking for model making, coating for arms and ammunition.

Plastics in Appliances

Moderator: R. E. Monica, *The Dow Chemical Co.*
On market goals: Harvey Weimer, *Whirlpool Corp.* – Slump in growth curve for plastics usage (only 2.5% increase last year) indicates need for better liaison between plastics industry and appliance industry, more emphasis on consumer education programs, more attention to quality and materials.
On design: C. W. Sundberg, *Sundberg & Ferar* – Economics which favor plastics will be key to tomorrow's markets. On this basis, designers will continue to specify plastics. Overcoming some current poor consumer reaction to plastics in appliances may simply be a matter of using improved plastics now available.
On appliance industry's needs: W. P. Gobeille, *American Motors Corp.* – Materials with improved fabricating qualities, greater rigidity, higher heat resistance, and improved abrasion resistance are in demand. The markets that could be developed with such materials are indicated by recent introduction of one-piece high-impact styrene food cabinet liner. Other developments to watch: foamed-in-place insulation for refrigerators, polypropylene agitators for washing machines.
On a successful use of plastics: P. J. King, *Bissell Inc.* – Plastics' contribution to success of company's Shampoo Master indicates potentials still to be developed in appliance field. Impact styrene, elastomeric vinyl, cellulosics, and nylon were key factors in design.

Plastics in Defense

Moderator: John K. Honish, *Union Carbide Plastics*
In weapons: Dr. Albert Lightbody, *U. S. Naval Ordnance Lab.* – Much consideration is being given to environmental problems in use of plastics in complex guidance, propulsion, and explosion devices. Potting of large electronic assemblies in such cases may be replaced by molded plastics parts to position metal components, with potting used to complete assemblies.
In over-all defense: Paul Forsyth, *Office, Secretary of Defense* – The Defense budget includes about $27 million this year for research and development programs in plastics, not including additional money spent in research on development of individual weapons prototypes and systems. In contrast, the Department spent only $16 million for all materials research and development 10 years ago.
In ship construction: William Graner, *Bureau of Ships, Dept. of the Navy* – Wider use is indicated (already all Navy craft under 40 ft. long are plastics; largest in service is 57 ft.; an 87-ft. all-weather job is in design) when more accurate standards for properties and handling characteristics are made available. In addition to hulls, applications include polyamide-epoxy tiles for sound damping around sonar, PVC pipe for radiological wash-down systems, foam for thermal and accustical insulation.
In space and missiles: Victor N. Saffire, *Missile and Space Vehicle Div., General Electric Co.* – Plastics have definitely proved themselves for such applications. All plastics components in Operation Mercury, including the couch, performed beautifully; the Echo satellite of polyester film is still in orbit. But much work on problems of solar radiation, and sub-microscopic particle and other forms of vehicle bombardment, is needed before plastics can help send a man into deep space and bring him back.

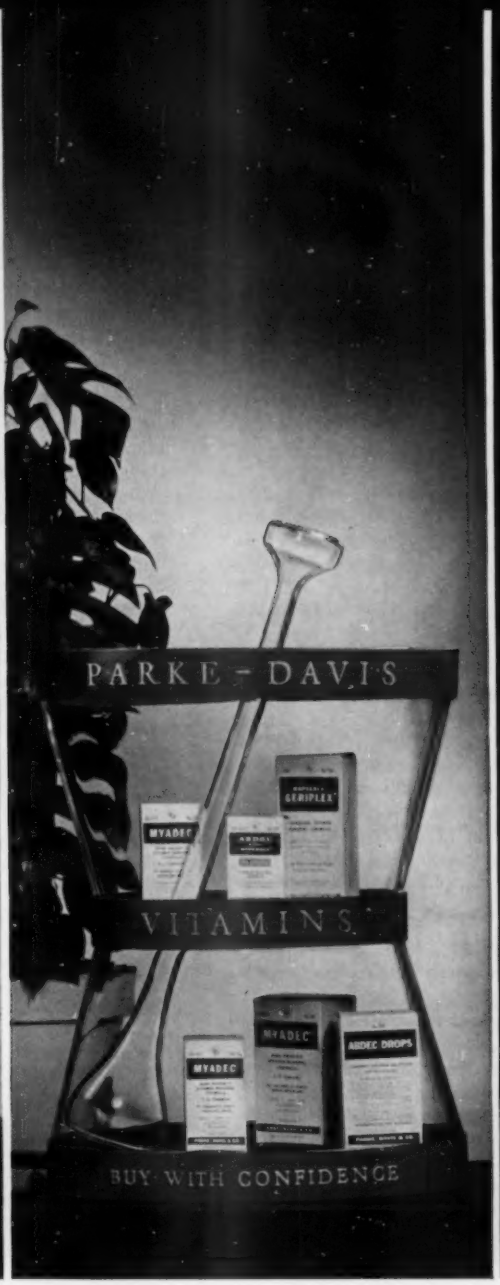


S.P.I. Cellular Plastics Division

Moderator: S. Steingiser, *Mobay Chemical Co.*
On foam in furniture: Richard C. Roe, *Schandig Corp.* – Foams have started automation trend in tradition-bound industry, but now we need uniform and meaningful tests for load-bearing characteristics, better compression density control, and more exact determination of causes for foam failure.
On foam in cryogenics: James Leonard, *Lique Freeze Corp. of America* – Use of plastics foam has really made the cryogenic industry possible (transportation and food processing); however, industry should work on lowering K factor, reduce foam weight, and above all, get cost down.
On foam in recreation: Kean Stimm, *Water Shoes, Inc.* – Polystyrene, urethane, and polyethylene foams are bringing completely new aspects to American leisure time, especially water sports, where they provide flotation in boats and make possible many lightweight, low-cost water toys. Cork, kapok, and other traditional materials cannot compete here.
On foam in industrial applications: William S. Schock, *The Dow Chemical Co.* – Markets here include roof insulation, perimeter insulation, foam-in-place wall sandwich structures, packaging, and transportation, among others. Future potential is vast.

Bachner Awards announced

Chrysler Corp. received the Second Bachner Award for an acetal housing for the instrument cluster of the 1961 Valiant during the Exposition festivities. A full report, with photos of the prize-winning and honorable-mention designs, will appear in the July issue.



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MODERN PLASTICS*

Volume 38, Number 10 June 1961

• THE PLASTISCOPE

Section 1 . . . . . **37**

Section 2 . . . . . **212**

Shell Chemical's marketing plans (p. 37); Another ethylene copolymer (p. 39); Round-the-world in plastics (p. 41); Over-capacity in urethane foam (p. 43); New markets for heavy-duty PE bags (p. 212); New companies . . . Expansion (p. 224).

• EDITORIAL

Don't count out the custom molder . . **79**

N.Y. SHOW REPORT . . . Inside front cover

After touring the exhibits and attending the conference sessions, MODERN PLASTICS editorial team summarizes the trends in materials, applications, machinery, and equipment in evidence at the 9th National Plastics Exposition in New York, spells out their significance to the plastics industry in the years ahead.

• GENERAL

Reinforced thermoset molding compounds **80**

No wonder there is a growing interest in the use of RP molding materials: in three recent applications, weight of a circuit-breaker was reduced 80%; a switch housing was reduced to one-half its former size, a small tank was produced at $1.00 less per unit than previous metal part. In addition, the materials provide mechanical and electrical properties that contribute significant product improvements. Here are the latest developments in this growing plastics field.

Molded tray withstands 450°F. **85**

Who would have thought we'd ever be cooking in plastic containers! But it's now possible with a compression molded tray said to be usable in conventional and radar ovens—and equally at home in the freezer. Cost is 4¢ per tray and initial market penetration is in the vending field. Use for frozen food packaging is expected.

Progress in self-extinguishing urethanes **86**

While urethane foams in self-extinguishing formulations have been available for some time, such flame resistance was generally obtained through the incorporation of additives which affected the final properties of the foam. Now a composition has been developed which has flame retardancy built directly into the molecule. As a result, much progress is expected in the use of such foams in the building and transportation markets.

Choosing colorants for polystyrene . . **88**

As modern merchandising techniques continue to place increasing emphasis on visual appeal, the importance of selecting the proper coloring agent grows apace. Here are the principles that govern the choice of colors for polystyrene molding. Two-page table lists available colors by type, color index, and color index number.

One-piece RP hull—67 ft. long **90**

The largest reinforced plastics boat hull produced to date points out the exciting design flexibility of the material. The hull is sleeker and more streamlined. It is also better and more economical to make. More important, some of the design concepts executed on the craft cannot be duplicated in wood at all, suggesting reinforced plastics' early penetration of the ocean-going vessel market.

Why the big market in polypropylene monofilaments? . . **92**

This month's cover story takes a close look at a market that in 1960 consumed one-third of all polypropylene production, and that by 1965 may grow to an annual volume of 35 to 40 million pounds. Each major market is analyzed, and potentials for the various applications are given in detail.

Let's not price ourselves into the red **96**

Pricing policies in the plastics industry often lead to low-profit or actual loss operations at processor levels. The plight of the pipe extruder presented here may well serve as a lesson to all plastics processors and fabricators. Through buying by the pound and selling by the foot, he has placed himself in a position where, while selling the same footage of pipe, his profits have shrunk to less than one-half. A detailed dollars-and-cents analysis traces the fallacy behind such pricing policies and suggests the price levels that must be established by the extruder in order to maintain a profitable operation. Implications to the rest of the industry are clear.

Fluorocarbon handles a sticky problem **98**

The experience of a candy maker in using fluorocarbons in its manufacturing and packaging operations suggests the tremendous efficiencies that can be achieved through this material in any number of industries handling "gooey" products.

Geodesic dome and underwater tunnel **100**

Fabricated and formed methacrylate sheet makes possible the first giant geodesic structure incorporating rigid transparent glazing. It also makes feasible the construction of a water-tight tunnel through which spectators get a fish-eye view of marine flora.

New Developments 157
RP molds for concrete casting . . . Phenolic upgrades cotton . . . Typewriter cover with integral hinge (p. 157) . . . Polystyrene foam-kraft sandwich structure, at 10¢/cu. ft., erected in less than one day (p. 158) . . . First plastic housing for Canadian typewriter . . . Cast epoxy rod for machining into electronic parts . . . Butyrate houses new checkwriter (p. 159) . . . Rigid PVC for home appliance parts . . . Molded RP case for hand dryer (p. 160) . . . PS housing for radio-phonograph . . . New shape for nylon sweeper bristles . . . Solid plastic furniture board (p. 162).

• ENGINEERING

A guide to radiation equipment 105
The use of atomic radiation to alter the properties of plastics materials is finding growing acceptance. Here is a discussion of promising radiation processes for high-molecular-weight chemical compounds, plus a detailed analysis of the economics of various types of accelerators. *By John W. Olander*

Thermoforming techniques for high-density polyolefin sheet 123
A material supplier reports on the conditions and molds that he found best in forming high-density polyethylene sheet by plug-, air-, and vacuum-assist techniques. Do's and don't's concerning the heating, forming, and cooling stages are presented. *By D. E. Allison and Robert Doyle*

• TECHNICAL

Formable thermosetting acrylic polymers 133
Flat, essentially thermoplastic sheets at an intermediate stage of cure are prepared, which are stable for long periods at room temperature. Upon heating to 110 to 300° F., these sheets can be stretched or formed in conventional molds. The cure of the formed specimens can be completed by heating to temperatures of 300 to 500° F. An intermediate treatment with ionizing radiation is required for the curing of stretched specimens. Optimum results were obtained with a two-component system containing diallyl itaconate and styrene and a five-component system containing diallyl itaconate, styrene, triallyl cyanurate, allyl methacrylate, and methyl methacrylate. *By Earl E. Parker and Thomas L. St. Pierre*

Allylic resins and laminates 143
Properties of molding compounds, prepregs and laminates of a material that has growing applications in radomes, nuclear devices, electronic instruments, chemical equipment, ablative elements, dinnerware, and decorative laminates. *By Harry Raech Jr. and J. L. Thomas*

Rheology of resinous coating materials 150
A new approach to coating rheology is expected to bring about a better understanding of coating properties, more rapid development of new materials, better material specification and better process control. *By Donald H. Briggeman*

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Coming Up . . .

Powder molding has finally taken hold and the first applications are on the market. Our July lead will outline the field and discuss the economics of the process . . . An expandable, plastisol-coated polystyrene foam . . . How to pick sheet for thermoforming . . . Polypropylene syringes . . . Engineering lead: Hot-hobbing of beryllium cavities . . . Technical lead: Ignition temperatures of plastics . . . Also in the works: Urethane foams—a new look at booming market . . . Special color effects . . . Polyethylene in radiation shielding . . . One-piece styrene acrylonitrile telephone . . . Filament winding goes commercial.

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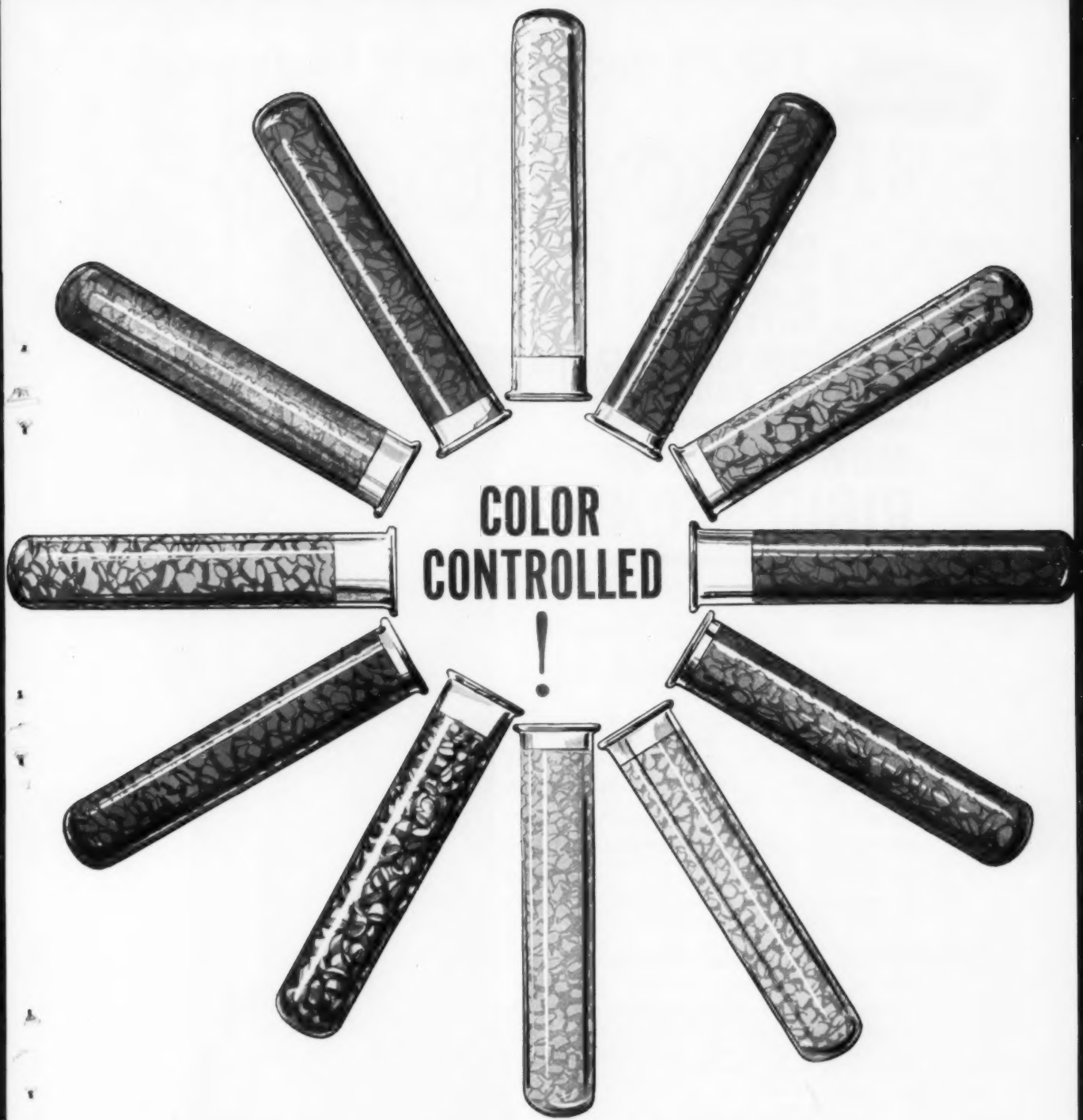

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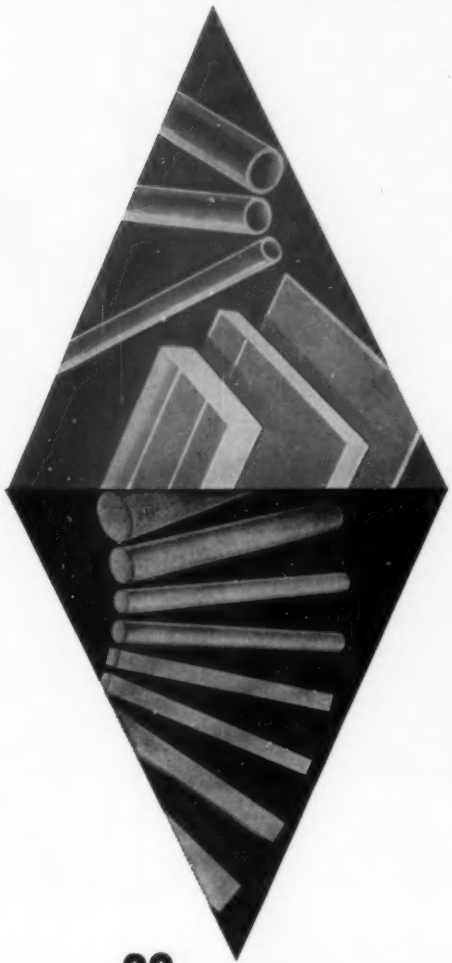

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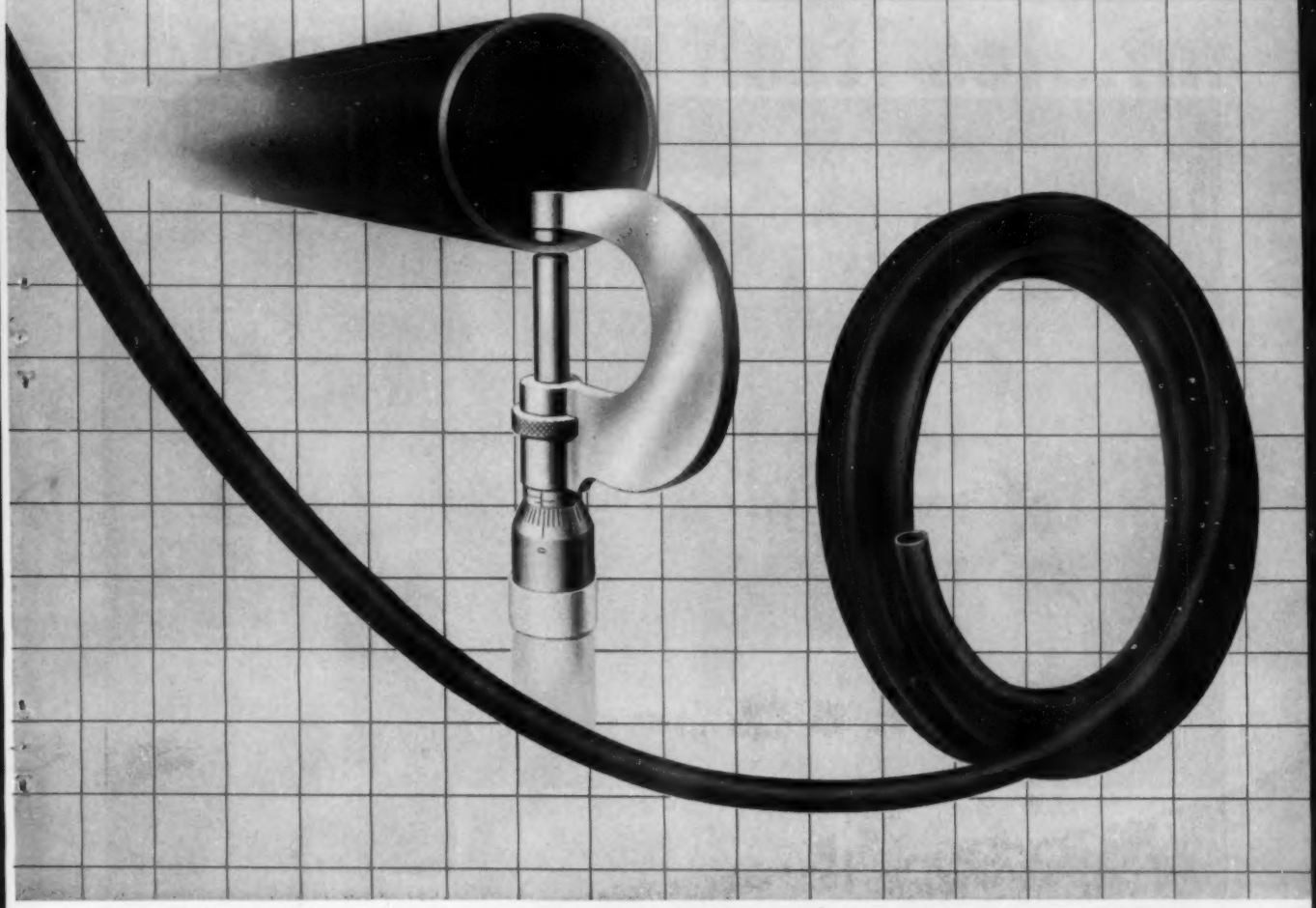

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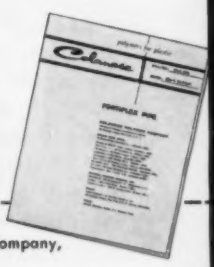

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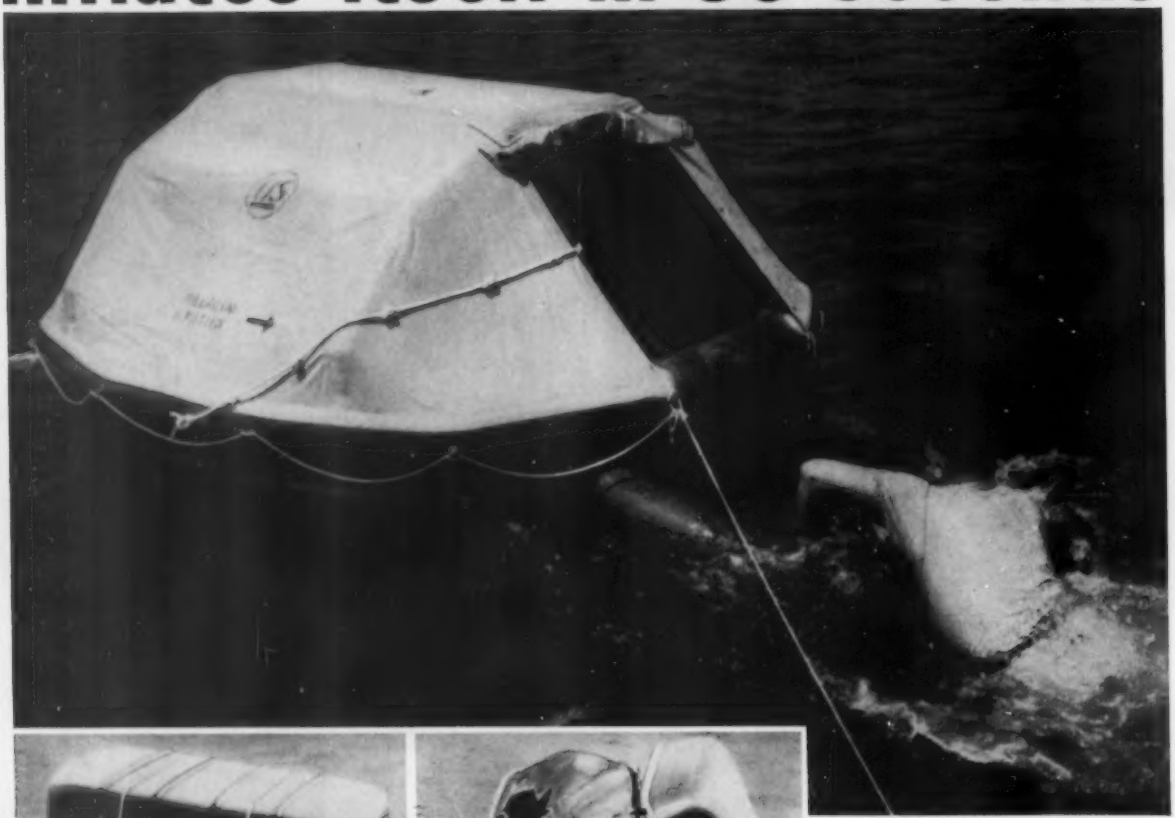

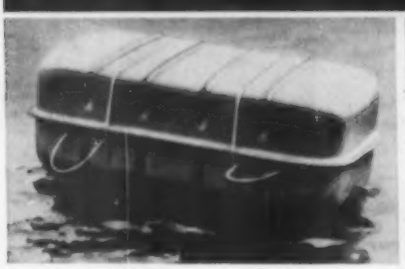

Case for raft is strong, buoyant "Exp-a-n-ded Royalite,"* strategically located on the weather deck. It is automatically released if the vessel sinks beyond a depth of ten feet—and pops to the surface.

This inflatable raft design utilizes a unique boarding platform and weatherproof canopy, has four separate air chambers in the hull and gunwale tubes to assure flotation in the event one is damaged.

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A product of United States Rubber Company, this raft is made of nylon fabric from Wellington Sears. Coated with neoprene and vulcanized, the strong, light fabric assures long life in both extended storage and service.

This new development in sea rescue has been used for several years by inland shippers, towing companies and yacht owners. Recently given the official approval of the U. S. Coast Guard, it will soon be supplementing lifeboats on many classes of passenger and cargo vessels.

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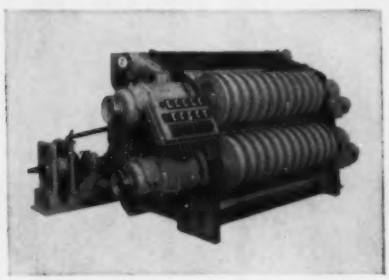


New sealer-handle designed for use on polyethylene bags provides an air-tight waterproof seal, then locks to form a convenient carrying handle. Current applications include packaging fruit, produce, toys.

It's of simple, one-piece construction—just a strip of .060 inch polyethylene with a horizontal center slit and interlocking hooked ends. To apply, top of the filled bag is pulled through the slit, the sealer-handle rolled downward and the hooks joined. To open, process is reversed. Neither sealing nor re-opening damages bag.

This device, also reusable, will reportedly hold any weight the bag will support. Since two separate bags can share a common sealer-handle, it's ideal for tie-in merchandising.

Polyethylene sealer-handle attaches in 4 to 5 seconds, can be used over and over.

Magazines Now Mailed In Polyethylene Film

Tight, Handsome Machine-Wraps Protect Better, Cost Less

Hand insertion of magazines into envelopes may soon be a thing of the past. A Midwestern printer now packages publications for mailing at the rate of 1000 magazines per hour, twice the rate of the hand operation!

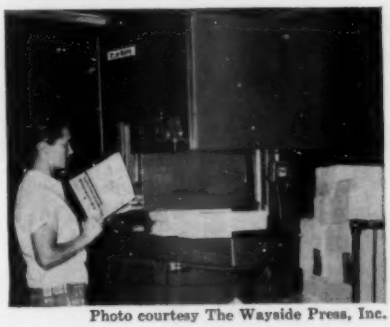


Photo courtesy The Wayside Press, Inc.

Publication is shown being packaged in polyethylene film. Magazines reach subscribers clean, fresh and undamaged.

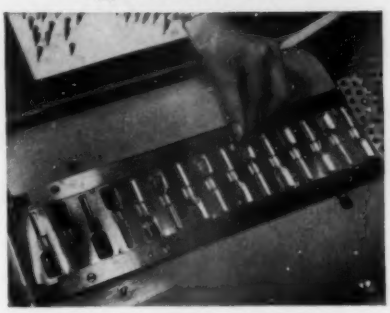
He uses rolls of 1.5-mil polyethylene film printed in two colors. A Model MA packaging machine forms bags around the magazines and heat-seals them tightly against moisture and dirt.

High Acceptance

The printer reports that after the first experimental mailing of 100,000 magazines, no complaints were received from either the Post Office or from subscribers. In fact, subscribers have written to the publishers expressing enthusiasm for the improved appearance of the mailed material and the better condition of the magazines on arrival. Front and back covers are clearly displayed through the transparent film.

The success of this printer with polyethylene-packaged magazines opens up a whole new field of possibilities for the mailing of printed matter. Improvements were achieved with no increase in overall costs. The advantages of mechanization, improved appearance, colorful package printing, and protection against soiling, rough handling, tearing and weather should not be overlooked by anybody who ships extensively through the mails.

Polyethylene Helps Package Hypodermic Needles



Polyethylene plays a multiple role in a new strip package developed in England for hypodermic syringe needles. The web materials used are polyethylene coated cellulose film and a laminate of .0035 mm aluminum foil and .0015 in. polyethylene film.

Novel automatic machines form shaped depressions in the foil web to receive the needles and, after these have been hand-inserted, complete the packs with the cellulose film cover and a polyethylene-to-polyethylene heat seal.

The finished strip is scored for easy tearing between each needle packet and cut after every twelfth. As a final step the needles are sterilized by permeating the package with ethylene oxide gas.

Polyethylene's toughness, resistance to bacteria and moisture-barrier properties also get into the act—keeping the needles sterile and ready for use almost indefinitely.

Did You Miss These?

Reprints of two recently published articles on polyethylene are currently available through U.S.I.:

1. "Poly Bread Wraps: Growth Continues," 4 pages, by William U. Funk, U.S.I. Sales Engineer.
2. "The Effect of Molecular Weight Distribution on the Flow Properties of Polyethylene," an 8-page technical report of experimental work conducted at U.S.I.'s Polymer Service Laboratories.

If you missed either or both of these timely articles, or would like extras for your file, copies can be obtained by writing Technical Literature Department, U. S. Industrial Chemicals Co., 99 Park Avenue, New York 16, N. Y.

IF YOU WOULD LIKE further information on any developments reported in U.S.I. Polyethylene News, U.S.I. will be glad to send you the names of the manufacturers. U.S.I. also invites you to send information on your new developments for possible inclusion in the News.

Address:
U.S.I. Polyethylene News, U.S. Industrial Chemicals Co., 99 Park Avenue, New York 16, New York.

The Long and Short of it:

The shorter film was cast from Airco's VINOL 125 polyvinyl alcohol; the longer, from a comparable grade of a competitive PVA resin. Both films were entirely immersed in 25°C water. Originally both samples were 10 cm long, 2 cm wide and 2.5 mils thick. Two hours later, the VINOL PVA film is 13.0 cm long; the other, 16.5 cm. In addition there is less swelling in the VINOL film.

VINOL POLYVINYL ALCOHOL RESISTS WATER BETTER

Because VINOL 125 resin is super hydrolyzed, films resist water better and retain more of their original strength and abrasion resistance. These properties are characteristic only of PVA produced by Airco's exclusive continuous manufacturing process.

Wherever water resistance is important in your product — in compounding wet strength adhesives; adhesives for difficult to bond surfaces; paper sizing and coating; binders for non-woven fabrics and ribbons — you should consider VINOL 125. Besides unusual water resistance, you also get outstanding clarity and color in VINOL 125 solutions and films.

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PPG 533 Roving . . . for filament winding, panels, rod stock

. . . highly effective wet-out with polyesters, phenolics and epoxies in producing translucent products with high unidirectional strength.

PPG 520 Roving . . . for spray-up applications

. . . provides close control in uniformity, cuts clean, dispenses freely, wets well, has color trace strand.

PPG 508 Roving . . . for preform molding

. . . drapes well, distributes evenly, conforms well, runs free of static, has high strength, cuts rejects to a minimum.

PPG Chopped Strand Mat . . . for sheets, boats, high pressure molding

. . . wets out faster than ordinary mat, has uniform fiber distribution; provides improved strength, appearance and workability; pure whiteness eliminates discoloration.

TECHNICAL HELP AVAILABLE

Samples of these quality reinforcements are available for trials in your own plant. A PPG technical staff man will be glad to answer any questions you may have and demonstrate techniques and machinery adjustments to get best production results.

For literature and other information, get in touch with your nearest PPG Fiber Glass Sales Office or regional distributor, or write *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pa.*

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Valvair does! How else can any manufacturer be sure that every valve he ships to a customer will function properly, from the first cycle on?

Each Valvair valve is cycled and re-cycled under water, at 30 to 50% above its rated pressure, to be certain that it meets Valvair's rigorous performance specifications. And, this final operating test is just one of the countless rigid quality control inspections each part of every valve must pass during its manufacture. In fact, one out of every twelve Valvair production men is a full-time inspector. Parts are scrutinized in process, as well as just prior to assembly. The most modern types of equipment, including optical comparators, surface finish indicators, optical and air gaging units, super magnifiers and precision gages, are used by the inspection team to assure Valvair's reputation for outstanding quality.

Specify Valvair components for the equipment you design, build or operate, to maintain your reputation for quality. For all the facts, write for Bulletin 59-SK, or call your nearby Bellows-Valvair Field Office. Address Bellows-Valvair, Akron 9, Ohio, Dept. MP-661.

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DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

8171

Air-Conditioner Grilles Of High Impact Polystyrene Molded On The Natco 400SX

"Our New Natco Molds 20% Faster"

. . . says Forrest Sheets, Factory Manager, Standard Molding Company, Dayton, Ohio

"Our new Natco 400SX has proven to be the ideal machine for our precision molding. In addition to its high speed, we also find the Natco easy to set-up, and it will repeat cycles with amazing accuracy."

"We have scheduled many tough jobs on our Natco, and each time performance has been good. Regardless of the molding problems . . . sinks, weld lines, close tolerances, varying section thicknesses . . . we know the Natco will do the job!"

Find out how a Natco can increase your molding profits. Write for Bulletin 2001 today. Stock sizes available from 12 to 140 oz. capacities.

NATCO

THE MOLDER'S MOLDING MACHINE

NATIONAL AUTOMATIC TOOL COMPANY, INC.

PLASTICS MACHINERY DIVISION

RICHMOND, INDIANA, U. S. A.

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Gel-Coat Spray System

mixes pigmented polyester resins at the nozzle, eliminates pre-mixing . . . reduces material waste

The new Binks Gel-Coat System mixes and sprays fast reacting multiple component materials. Pigmented polyester resins are fed from separate pressurized tanks to the Binks spray gun. Controlled orifices at the gun head proportion and mix the materials. This eliminates metering and controls.

Binks Gel-Coat System is pretested . . . shipped completely assembled. Just four simple steps and you're ready to spray: 1. attach hoses; 2. add resin to tank; 3. dilute catalyst; 4. hookup hood respirator and set spray pressure.

Ask your Binks representative to show you how this new Gel-Coat System solves the pre-mix problem . . . or write direct for Bulletin A-101-5.

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Binks Manufacturing Company 3134-A Carroll Avenue, Chicago 12, Ill.

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1208

Binks Everything for spray painting

Gering Quality Molding Compounds Answer Your Demands...

• for the fullest color range with uniformity from batch to batch • for exact physical properties that improve production by fewer rejects and faster molding cycles • for money-saving, quality-formulated *polyethylene, polypropylene, vinyl, polystyrene, styrene copolymers, acetate, nylon, acrylic and butyrate.*

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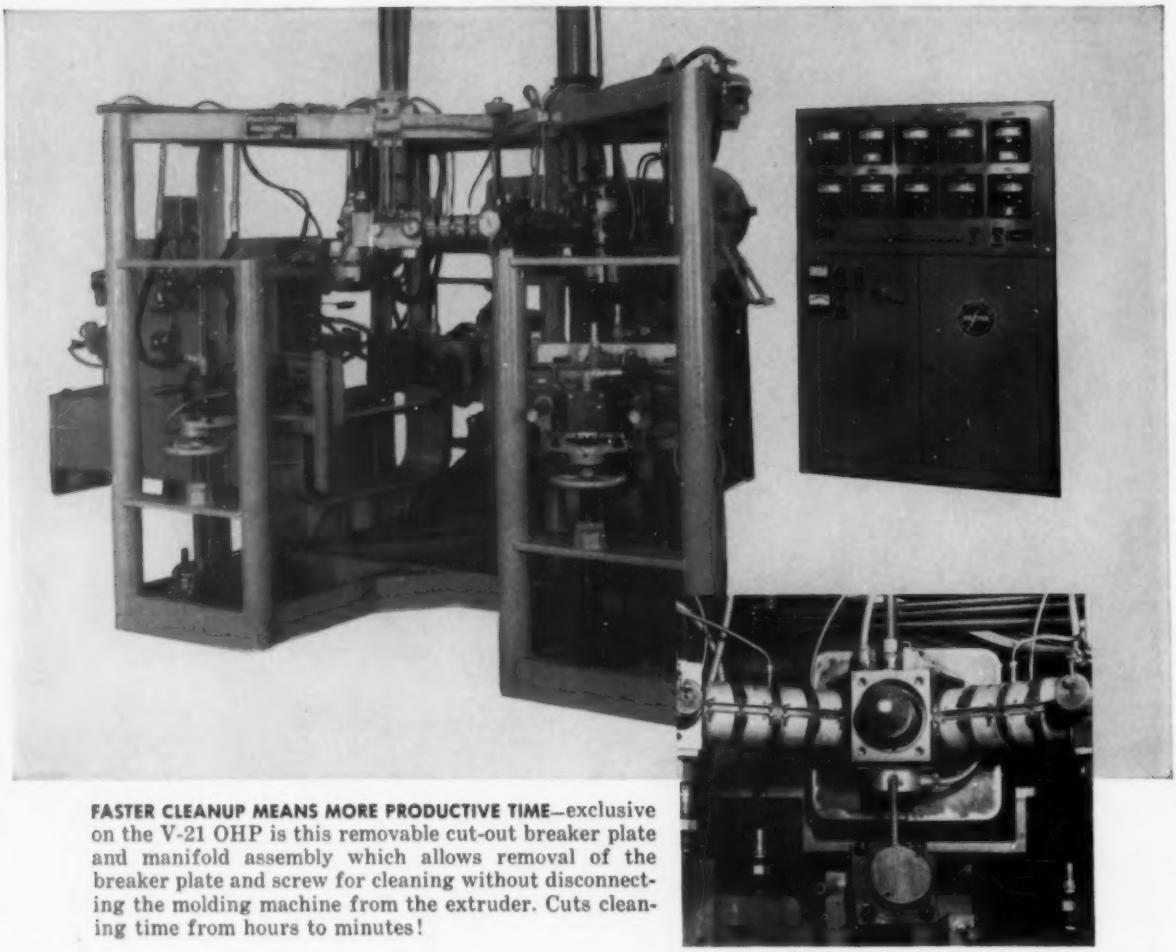


FASTER CLEANUP MEANS MORE PRODUCTIVE TIME—exclusive on the V-21 OHP is this removable cut-out breaker plate and manifold assembly which allows removal of the breaker plate and screw for cleaning without disconnecting the molding machine from the extruder. Cuts cleaning time from hours to minutes!

FOR BLOW MOLDING, MPM'S MADE THE TWO STATION

V-21 OHP Diversamatic faster more versatile than ever!

WITH FULL HYDRAULIC OPERATION AND SEPARATE X-ALOY-LINED ACCUMULATOR FOR EACH STATION

HIGH SPEED FOR HIGH PERFORMANCE— Diversamatic's unique twin-station design almost doubles your production. As one station is cooling the other is extruding and forming, giving you continuous, uninterrupted operation. And, Diversamatic with multiple heads on each station has been production run at speeds up to 1,500 one-quart bottles per hour.

VERSATILITY FOR HIGH PERFORMANCE—Either identical or different molds can be run at the same time, making it possible for you to produce a *different* item on each of the two stations. You can use up to *four* heads on each station for even greater versatility—greater speed. Separate accumulators on each station assure you of highly accurate parison delivery.

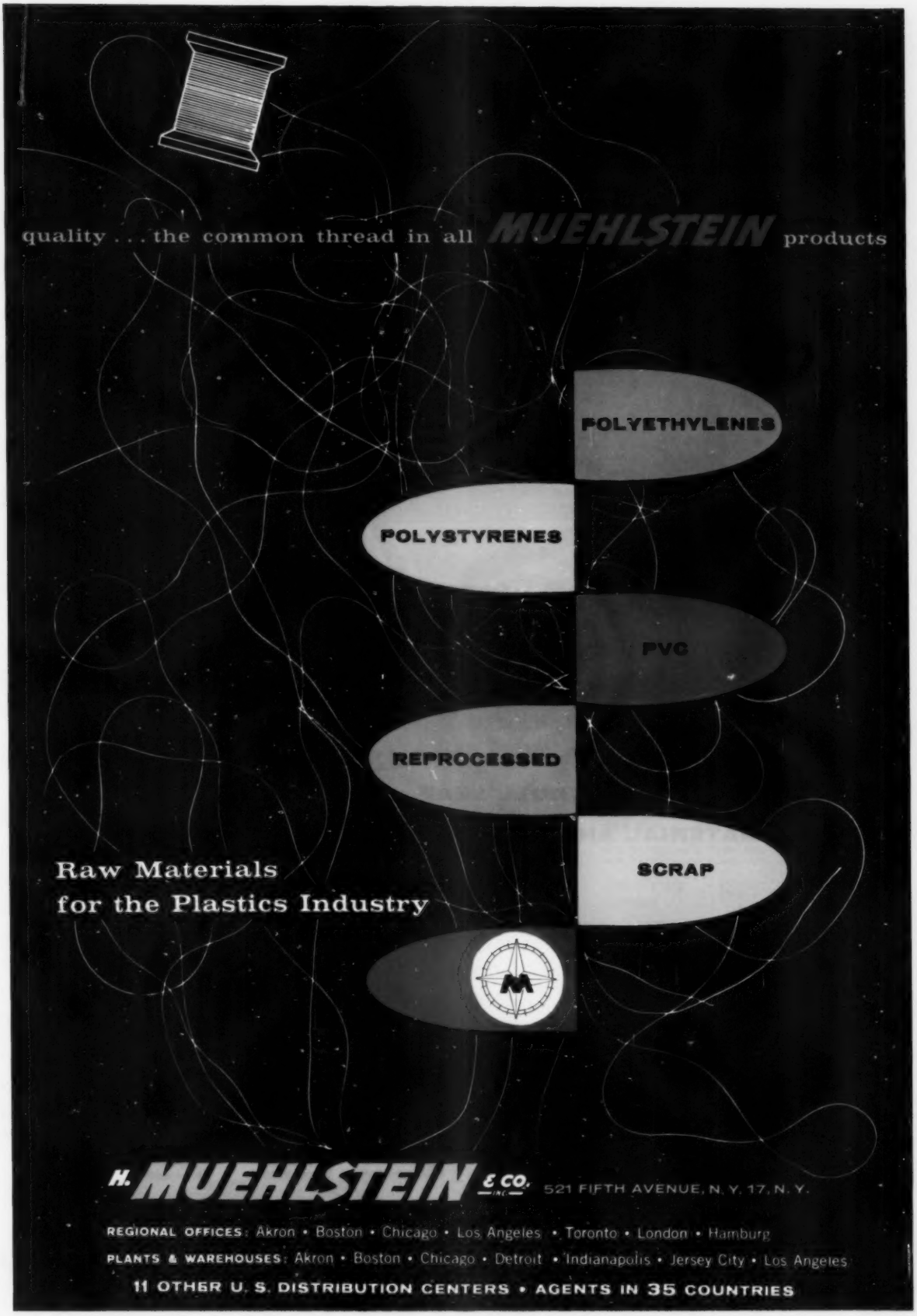
EASY OPERATION CUTS YOUR COSTS—Diversamatic is fully automatic, being controlled electronically by a nearby console. The machine also has manual controls for fast mold set-up and test runs. It requires minimum operator supervision, and is so simple to run that it is being operated by persons having no previous experience or knowledge in the plastics field.

MPM's COMPLETE MANUFACTURING FACILITIES—no mere assembler, MPM manufactures all its components, then pilot tests the completed unit. When you choose MPM, you can arrange to see your equipment in operation before it is shipped.

Write today for full information on MPM blow molding equipment. Manufactured under U.S. Patent 2980955. Other patents pending.

Modern Plastic Machinery Corp.

General offices and engineering laboratories: 64 Lakeview Avenue, Clifton, N. J.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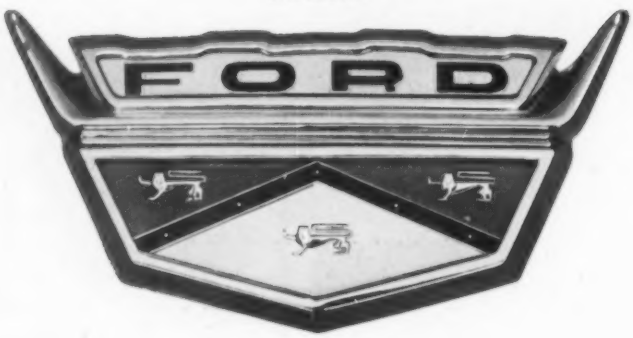

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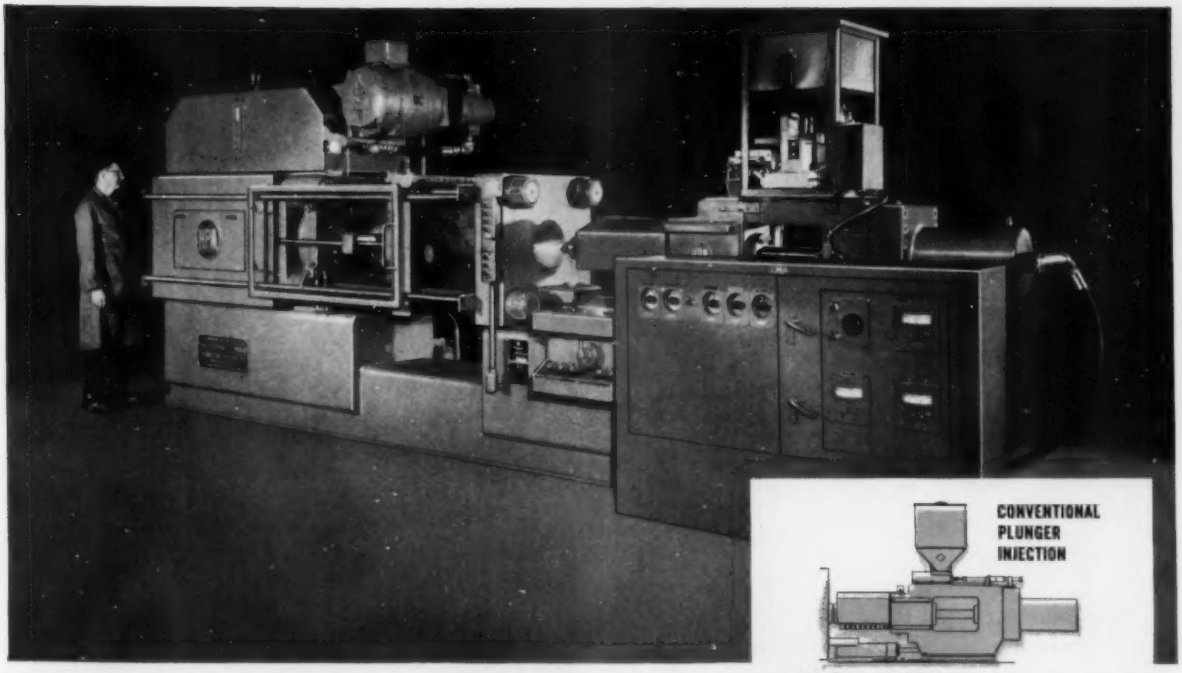


This is an H-P-M 350 ton machine with a material capacity of 12/16 oz. per cycle (Model 350-HV-12/16). It is equipped with a 30 HP booster power unit to increase injection rate. The smaller H-P-M 200 ton clamp machine is similar to this machine in appearance.

What do YOU need?

in 200 and 350 ton Injection Machines

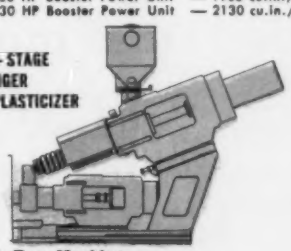
With these two popular H-P-M injection molding machines, in the 6 oz. to 28 oz. range, you can get just what *you* need "custom-built" from a broad selection of standard elements. Check at the right the different injection combinations available with 200 or 350 ton clamps, and each available with optional booster power units for increased injection rates. They're fast, dependable and easily maintained. Unit construction of standard H-P-M machines permits almost unlimited variety of machine design at great savings. Contact us, today, for complete information.

H103

CONVENTIONAL PLUNGER INJECTION

200 Ton Machine —
6/8 oz. Capacity — 675 cu.in./min.
with 20 HP Booster Power Unit — 1350 cu.in./min.

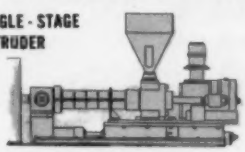
350 Ton Machine —
12/16 oz. Capacity — 1230 cu.in./min.
with 20 HP Booster Power Unit — 1905 cu.in./min.
with 30 HP Booster Power Unit — 2130 cu.in./min.



TWO-STAGE PLUNGER PREPLASTICIZER

200 Ton Machine —
28 oz. Capacity equipped with
20 HP Booster Power Unit — 1320 cu.in./min.

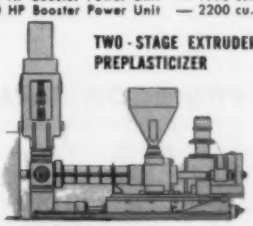
350 Ton Machine —
28 oz. Capacity — 1210 cu.in./min.
with 20 HP Booster Power Unit — 1885 cu.in./min.
with 30 HP Booster Power Unit — 2110 cu.in./min.



SINGLE-STAGE EXTRUDER

200 Ton Machine —
15 oz. Capacity — 690 cu.in./min.
with 20 HP Booster Power Unit — 1380 cu.in./min.

350 Ton Machine —
15 oz. Capacity — 1300 cu.in./min.
with 20 HP Booster Power Unit — 1990 cu.in./min.
with 30 HP Booster Power Unit — 2200 cu.in./min.



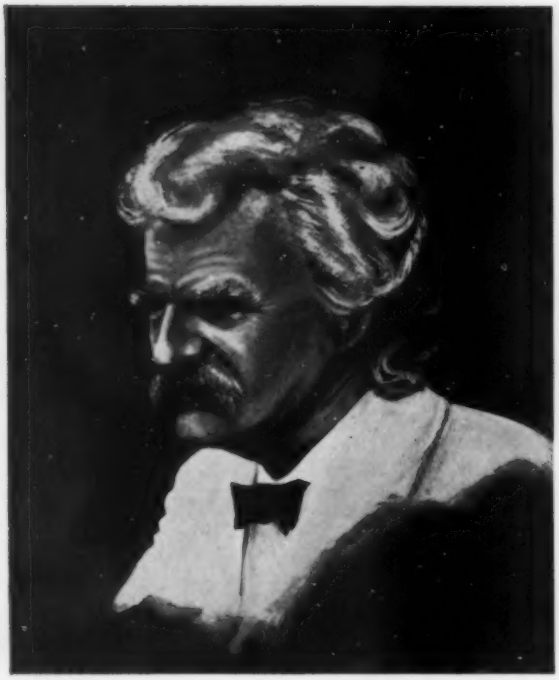
TWO-STAGE EXTRUDER PREPLASTICIZER

200 Ton Machine —
28 oz. Capacity — 675 cu.in./min.
with 20 HP Booster Power Unit — 1350 cu.in./min.

350 Ton Machine —
28 oz. Capacity — 1230 cu.in./min.
with 20 HP Booster Power Unit — 1905 cu.in./min.
with 30 HP Booster Power Unit — 2130 cu.in./min.

H-P-M DIVISION
Koehring Company

Mount Gilead, Ohio, U. S. A.



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We have moved to larger facilities in Anderson, Indiana. Yes, we're so much alive that our . . .

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- *Complete pipe and shapes line . . .*
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EXTRUDE AT HIGHER TEMPERATURES, WITH EXACT CONTROL

Designed for 10,000 PSI extruding pressures, with a 20:1 diameter-to-length ratio, and liquid cooling system with electric heating, the new Lynch extruder gives you all the advantages of high temperature operation, plus precise control.

Included are extruder, dies and haul-off equipment.

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An end at last to wielding soggy mops, wringing dirty sponges, and all of the other unpleasant tasks that go with washing floors. That's what The Hoover Company of North Canton, Ohio, has done for the American housewife. Hoover's revolutionary new electric floor washer wets floors with clean water and detergent, scrubs them thoroughly, and vacuum dries them—all automatically!

In designing this unique appliance, the close juxtaposition of water and electric motor demanded that a material with high insulating properties be used in molding end plate and fan chamber. Hoover engineers found that Plenco 507 phenolic molding compound provided the insulating qualities, moisture resistance, as well as excellent dimensional stability required.

The story is the same with other leading manufacturers: an unusual product, component, or molding problem—usually answered with the help of versatile Plenco phenolics. That's true whether your specifications call for a special-purpose or general-purpose molding compound, ready-made or one that's custom-formulated. You're welcome to explore the possibilities with our technical staff at any time.

PLASTICS ENGINEERING COMPANY

Sheboygan, Wisconsin

Serving the plastics industry in the manufacture of high grade phenolic molding compounds, industrial resins and coating resins.

PLASTIC DESIGN IDEAS THAT MAY GIVE YOU AN IDEA

Foam plastic makes this boat unsinkable

The hull of this 11 ft. sailboat, designed to sell for under $100, is one solid piece of foam plastic—DYLITE® expandable polystyrene. Because of its tight cell structure and light weight, this amazing material has unmatched buoyancy. The boat stays afloat even if it's completely flooded. It can't become waterlogged because DYLITE doesn't absorb water. The hull weighs only 30 pounds, yet it can support over 500 pounds. Another Koppers plastic, DURETHENE® polyethylene film, is used in the durable yellow sail. Boat manufactured by Snark Products, Inc., Fort Lee, New Jersey.

Cooler liner formed without thin spots

The interior liner of this Hamilton-Skotch picnic chest is thermo-formed from SUPER DYLAN® high-density polyethylene. This impact-resistant plastic is used because it's the only polyethylene that can be formed into this difficult deep-draw piece without producing thin spots or mold marks. The seamless liner won't leak, absorb food odors or water. Its smooth, white finish can't stain, discolor, rust or corrode—it's easy to keep clean. Bottles, cans and chunks of ice won't mar or crack its tough surface. Cooler Chest Manufactured by The Hamilton-Skotch Corporation, New York 16, New York.

Foam trays simplify toy packaging

A. C. Gilbert Company uses DYLITE expandable polystyrene trays because they completely eliminate costly interior packing materials. DYLITE trays are strong, good looking, easy to assemble and load—they save on labor costs. They also cut shipping costs because they're extremely lightweight.

DYLITE packages come in any size or shape; they fit firmly around the product and protect it from shipping damage. They make an attractive display because their smooth, colorful surface won't smear, chip or flake. DYLITE parts molded by Sullifoam Products, Willow Grove, Pennsylvania.

Flashlight guaranteed not to break

This new right-angle flashlight case is guaranteed unbreakable because it's molded from strong DYLAN® polyethylene. It's colorful, can't chip or flake. Unlike metal flashlights, it won't rust or corrode and it's completely acid-proof.

Koppers has a wide range of polyethylenes available for almost any application. They come in densities from .914 to .953 gm./ml. By varying density, molders or design engineers can get varying degrees of stiffness, heat distortion and tensile strength. Remember too, that polyethylenes can give you a wide range of colors. Flashlight manufactured by J. P. Gits Corp., Chicago, Illinois.

KOPPERS PLASTICS

Find out how Koppers family of plastics can help improve your product at less cost. For more details write Koppers Company, Inc., Plastics Division, Dept. 1528, Pittsburgh 19, Pa.

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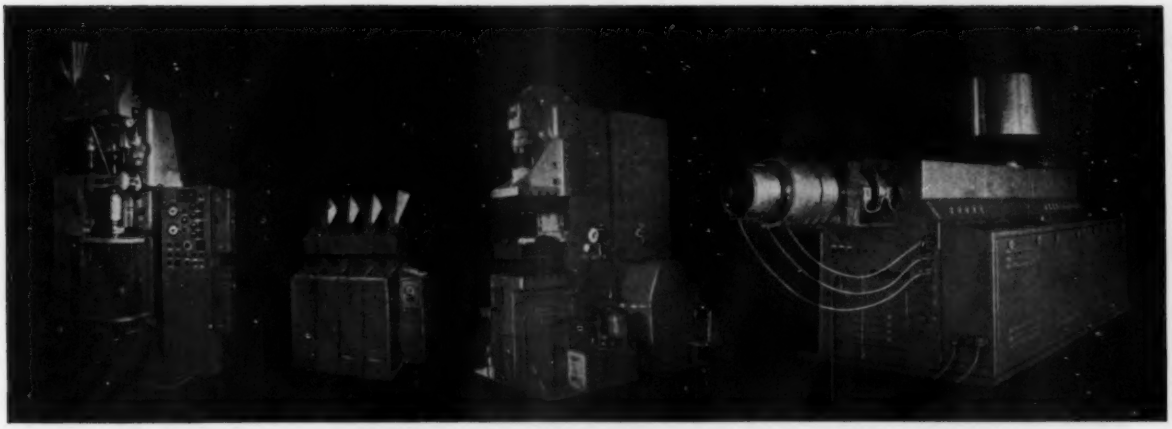

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with piston and screw feed
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Compression and Transfer Molding Machines
up to 300 tons capacity

Extruders and complete Auromatic Plants
(with screw diameters
1¼" 1¾" 2½" 3½" and 6" approx)

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from 1/10 oz. upwards

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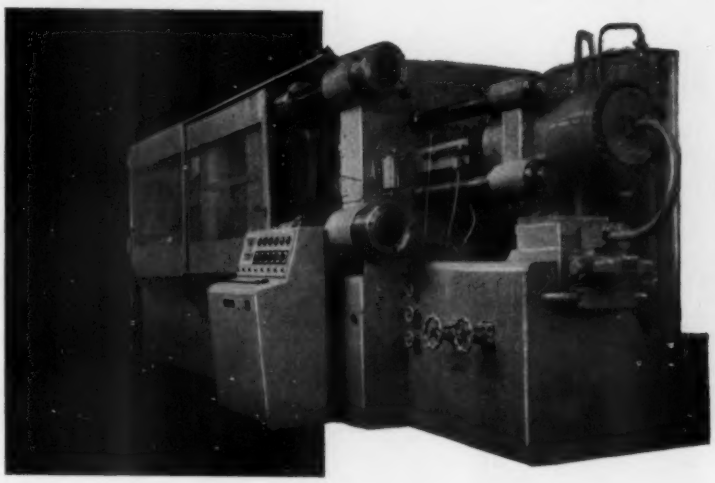
SCREW PLASTICIZING UNIT
from 1 – 350 OZS



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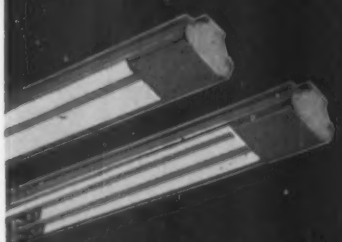
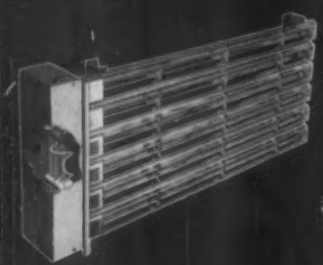
better temperature control, less rejects, better products

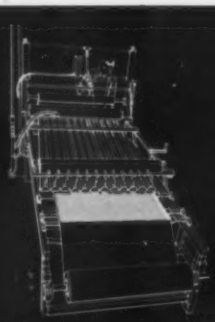
Chromalox variable control panel with master switch for accurate control of radiation output.



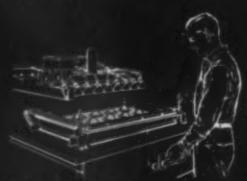
Chromalox Electric Radiant Heaters with single or double heat sources in lengths from 24" to 185".



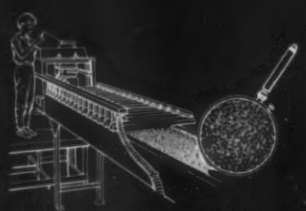
Chromalox prefabricated high intensity Radiant Panels designed especially for curing and heat setting in web-type operations.



Chromalox Infrared Heat delivered at right temperatures helps maintain uninterrupted production of laminated plastic tubes.



Automatic control of Chromalox Radiant Heaters provides uniform vacuum forming of plastic for variety of uses.



Automatically controlled heat from a battery of Radiant Heaters turns out uniform size beads from polystyrene bubbles.

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NEW YORK CITY, N. Y.	WOrth 4-2990
OMAHA, NEBRASKA	341-7600, 7610
PHILADELPHIA, PA.	GReenwood 3-4477
PITTSBURGH, PA.	EMerson 1-2900
PORTLAND, OREGON	Capitol 3-4197
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ROCHESTER, N. Y.	HAmilton 6-2070
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Chromalox Far-Infrared Radiant Heaters generate even heat without hot or cold spots, heat that is absorbed with equal speed by all colors and textures, heat which can be controlled from 4 to 100% capacity to fit the exact temperature needs of the job. Available from stock in a vast array of sizes.

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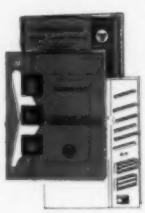
Send for Infrared Catalog G-62, Industrial Process Catalog 60, Comfort Heating Catalog F975D



W1-8

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7503 THOMAS BLVD., PITTSBURGH 8, PA.

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Just tell us the nature of the material—polyester, acrylic, fiber glass, rubber, or whatever—and give us your production specifications. We'll build the right compression molding press to meet your needs.

Erie Foundry regularly builds hydraulic molding presses in capacities of 25 to 4,000 tons. Our advanced design control systems will apply forces accurately and precisely, maintain platen temperatures within close tolerances, and perform molding cycles with split-second timing. Versatility is built in so that a wide range of molding jobs can be handled.

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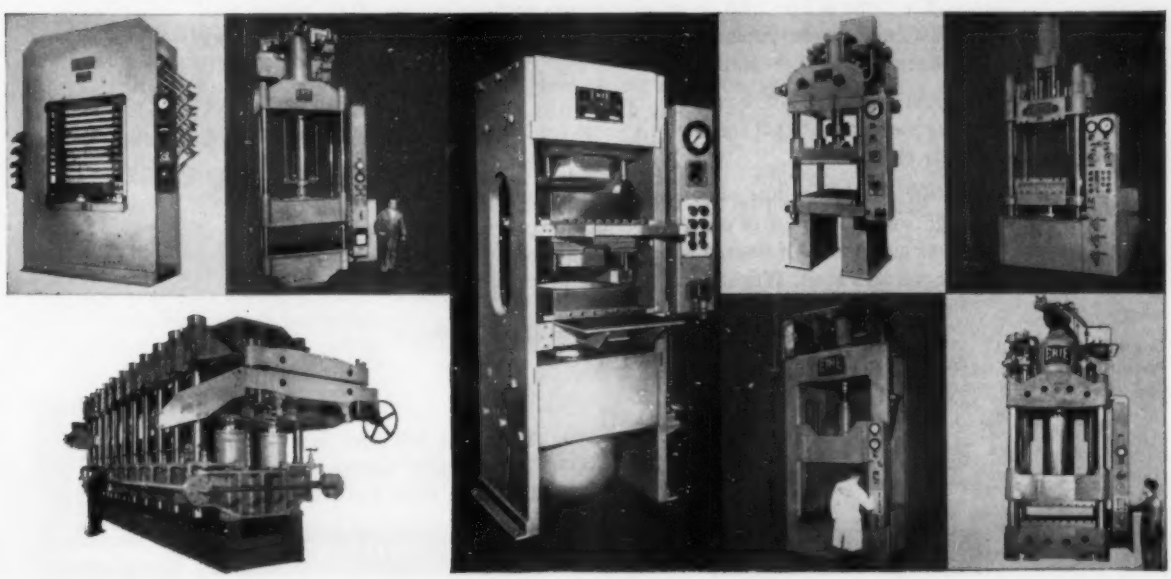

Solving unusual problems with Riegel papers

Riegelease™
easy-peeling papers
Uses: Pressure sensitive adhesive liner for emblems, labels, tiles, films, tape . . . and separating or interleaving paper.
for the stickiest adhesives

Choosing a release paper that will keep pressure-sensitive adhesives clean and sticky, and still peel easily, requires careful study. Every adhesive is different. Even the same adhesive varies when applied to different materials . . . and it varies with the coating process used.

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Users of pressure-sensitive adhesives and tacky materials of all sorts have been coming to Riegel for over 15 years for help in solving important release paper problems.

The Riegelease line of release papers is available in several weights with a variety of coatings, one or two sides, on colored papers and printed if desired. Our technical data folder is your best place to start. Write for it . . . you'll get samples too.

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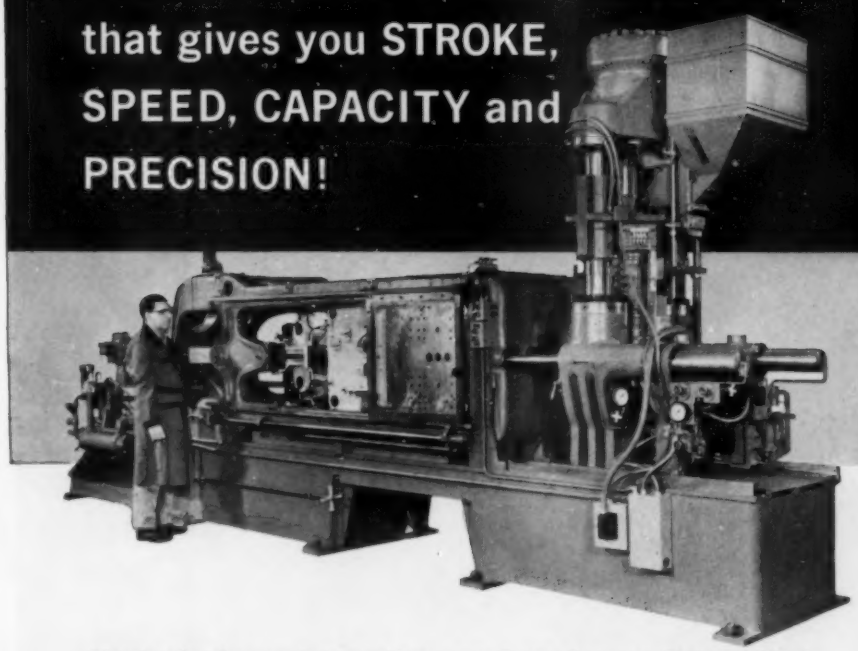
TECHNICAL PAPERS FOR INDUSTRY

NOW! A 24/32 ounce LESTER that gives you STROKE, SPEED, CAPACITY and PRECISION!



Here's why the new L-500-24/32 ounce Lester has won the unqualified approval of critical molders, who are using it to produce quality parts, such as those shown here. It has:

STROKE...a full 30″ of mold opening (adjustable by simple hand crank at the link cylinder to 8″). The maximum mold height of 30″ is conveniently and rapidly reduced to any dimension down to 9″ by use of the 3″ travel of the large central adjusting screw, in combination with standard 3″, 6″, and 9″ spacer rings.

SPEED...an overall cycle, at the 8″ mold opening, of only 7¼ seconds —at the 30″ movement, only 9 seconds. The high speed plunger stroke is aided by a rapid advance differential system, to provide a healthy 48 cu. ins. per sec. of filling speed during the major portion of the stroke.

CAPACITY...the most fully proven, simplest, trouble-free cylinder in the industry, capable of plasticizing 300 pounds per hour of general purpose polystyrene. The advantages of the vertical injection system include retractability for easy purging and the famous, foolproof, Lester nylon cutoff attachment.

PRECISION...the one-piece cast-steel frame provides 500 tons of CERTIFIED clamp that cannot go out of adjustment. The fully supported movable platen is aligned with mold-maker's accuracy to assure flash-free parts and longer mold life.

The L-500-24/32 ounce Lester—the modern machine for modern materials—is producing profits for molders of housewares and lenses, toys and pipe fittings. It can do the same for you. Write for specifications.

Laundry Basket—29 ounces of linear polyethylene—14½" deep.

Toy Truck Body—21 ounces of modified acrylic—high gloss finish.

Automotive Air Shroud—19½ ounces of high-impact, high-heat styrene.

Chair Seat—28½ ounces of high-density polyethylene—256 square inches.

LESTER INJECTION MOLDING MACHINES

Distributed by **Lester-Phoenix, Inc.** • **2621J Church Avenue** • **Cleveland 13, Ohio**

Agents in principal cities throughout the world

TRAFFIC MANAGER – This phenolic laminate strip being inserted in a letter tray in New York's General Post Office plays a vital role in routing mail along a conveyorized "mail flow" system. Adopted by the Post Office in many principal cities, mail flow systems have elevated efficiency by relieving postal employees of the need to hand-carry mail between sorting stations. The New York Post Office now handles approximately 34 million pieces of mail every 24 hours! And during the four-hour peak traffic period of the average day, letter trays make an average of 10,000 trips over the conveyors linking the primary sorting stations with secondary sorting stations. Called "signal cards," these phenolic laminate strips have windows cut into the face of each card which exposes a stainless steel center ply in a pattern keyed to one of the secondary stations. When the tray arrives at the proper station, the signal card key-pattern electrically actuates a mechanism that diverts the tray from the conveyor to its proper destination. Laminated phenolic was specified for the signal cards because of its durability, light weight, and positive electrical insulation. These cards were produced by Taylor Fibre Company, Norristown, Pa., and made with Mount Vernon duck.

This is another example of how fabrics made by Mount Vernon Mills, Inc. and the industries they serve, are serving America. Mount Vernon engineers and its laboratory facilities are available to help you in the development of any new fabric or in the application of those already available.

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New simplified spray gun applies dual component materials as easily as paint

And it's as easy to handle as a conventional spray gun. ▪ Because it has sensitive, accurate adjustments for producing normal fan or round type spray patterns, no special spraying technique to attain more uniform film builds is required. ▪ Gun is designed to spray lower viscosity polyester materials, attaining improved intermix, better flow-out and higher film build. ▪ Component materials mix thoroughly in the spray pattern as they leave the gun and before they reach the surface. ▪ This intermixing outside the gun eliminates problems of material setup in the nozzle and the need for immediate gun flushing characteristic of short pot life mixtures. ▪ For full details on the new DeVilbiss dual component spray gun, write us direct. The DeVilbiss Company, Toledo 1, Ohio.

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SPENCER® "Poly-Eth" Polyethylene

SPENCER CHEMICAL COMPANY, Dwight Building, Kansas City 5, Missouri

Among the important factors in Shell Chemical's decision to make polystyrene were its extensive background in polymers and its raw material position. Two other Shell thermoplastics followed quickly—polypropylene and polyethylene.

BULLETIN:

On May 3, 1960, a remarkable thermoplastics decision was made by Shell Chemical

Read about this Shell decision. And how you can start benefiting today from a major new source of polystyrene, polypropylene and polyethylene that resulted from it.

On MAY 3, 1960, Shell Chemical, a company long basic in styrene monomer and SBR rubber, decided to combine the two in full commercial production of Shell high impact polystyrene. Why was this remarkable?

A revealing fact on polystyrene

The condition of the polystyrene market was not attractive. There was oversupply from some of America's finest companies. The field was mature and Shell was starting late.

One revealing fact offset this situation. *Shell, with its excellent background in polymer chemistry—as exemplified by Shell Isoprene Rubber, the industry's first commercially produced synthetic/natural rubber—could make positive contributions to the thermoplastics field in the form of new products.* But Shell would be severely handicapped without a thorough understanding of how the thermoplastics market works and what it wants.

Result? Shell's decision to go full speed ahead with high quality general purpose, medium and high impact Shell polystyrenes, plus a rapidly expanding technical sales force.

80 million pounds of polypropylene

Two other thermoplastic developments followed quickly.

One, Shell's announcement in October, 1960, for an 80 million pounds a year polypropylene plant with customer service and research facilities to be built near Woodbury, N. J. Two, an arrangement by which Shell will resell limited quantities of polypropylene until this plant comes on stream.

Custom-made polyethylene

And this, in turn, led to a third important thermoplastic.

In order to round out a complete line of thermoplastics, Shell Chemical, in January, 1961, made arrangements to supply the industry with the highest quality custom-made polyethylenes.

How to start benefiting

Thus, within 8 months, Shell became an important factor in three plastics: Shell polystyrene, Shell polypropylene and Shell polyethylene.

The next 8 months should be even more important. Shell will be going full speed ahead searching for new polymers you want.

Now is the time to let Shell's technical representative know your needs. Tell him about them on his next visit or write Shell Chemical directly at:

42-76 Main St., Flushing 55, N.Y. FLushing 3-4200; 20575 Center Ridge Rd., Cleveland 16, O. EDison 3-1400; 6054 West Touhy Ave., Chicago 48, Ill. SPring 4-6711; or 10642 Downey Ave., Downey, Calif. SPruce 3-0601.

A Bulletin from

Shell Chemical Company

SHELL

Plastics and Resins Division

THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

Section 1 — June 1961

Shell Chemical makes marketing plans to handle increased plastics business

When Shell Chemical made its arrangement with Union Carbide to obtain polyethylene from that company in exchange for polypropylene to be supplied by Shell's new PP plant, it expanded its plastics potential many-fold. Since the ways of the plastics industry have always seemed strange and puzzling to the petroleum people, and vice versa, it is interesting to watch how Shell proposes to handle its enlarged responsibilities in plastics.

Shell Chemical is a pioneer in petrochemicals: it began making chemical products from gases in 1929. Its first plastic was Epon epoxy, introduced in the late 1940's. Polystyrene production began in the mid-Fifties. Then came the recent arrangement for PE from Union Carbide and the 80-million-lb. PP plant which is expected to begin production near Woodbury, N. J., in mid-1962.

Organizational changes to handle the increased business are now taking form. Because of the diversity of its chemical products, the company, in 1958, set up its five divisions. One of these was the Plastics & Resins Division, which at the time of its formation had only one major product: epoxy. This division has now been divided into two subdivisions. One, called "Resins," will handle thermosets or epoxy. The other, called "Plastics," will handle thermoplastics. The two subdivisions will be under its own general manager, and reporting to him will be managers for the marketing, research and development, and manufacturing departments.

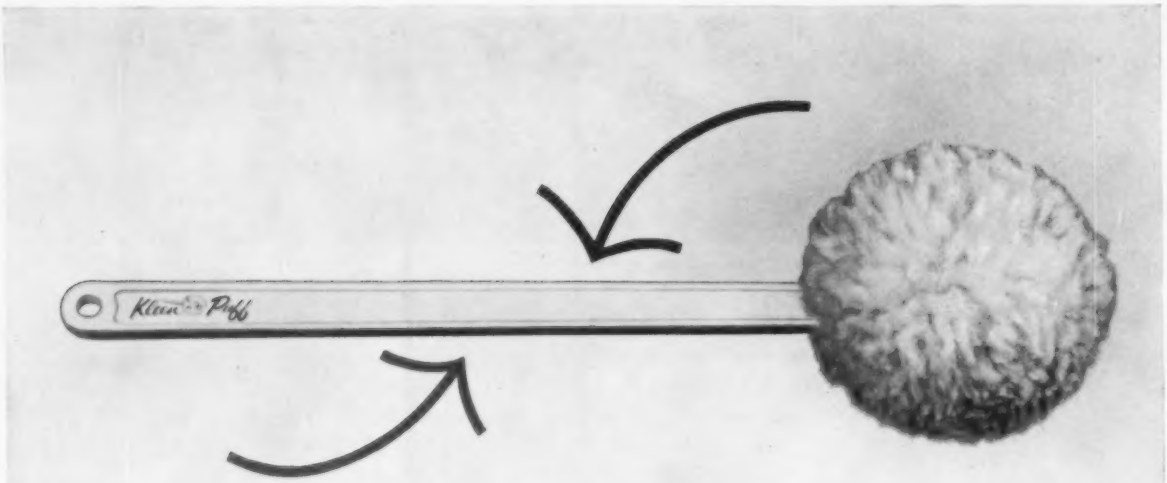
The marketing organization is headed by a manager of marketing and then structured into line and staff organizations. The line organization consists of the sales manager and his staff plus four district sales offices. The staff organization consists of two product departments: the resins department and the plastics department. They are responsible for product logistics, planning, and the generation of sales programs.

Research & Development tie in with marketing

Shell's R & D staff in New York is headed by a manager with departments for both Resins and Plastics developments. These groups will utilize the company's research laboratories in Houston, Texas; Torrance and Emeryville, Calif., and Woodbury, N. J.; where new product possibilities and improvements will be studied. A thermoplastics center will be established at Woodbury, with particular emphasis on customer relationship through the marketing department.

Shell admits that the plastics business is different from its business in other chemicals; in plastics there is a "oneness" which makes it inadvisable to separate the manufacturing, R & D, and marketing facets of a plastics problem, and the firm hopes to bring all of them together on a problem simultaneously. New products to be stressed at the moment are rigid epoxy foam, an improved epoxy concrete surfacing material for skid protection and reduction of maintenance costs, and new high-impact polystyrene with solvent resistance to withstand crazing effects of Freon-blown insulating foams. **(To page 39)**

*Reg. U.S. Pat. Off.



CMPC-molded mop handle has built-in germ fighter

Often, engineered plastics add important extra sales features to a product. A good example is the "Kleen-Puff"® mop, manufactured and sold internationally by the Zelinkoff Company of Wichita, Kansas.

CMPC injection molds the one-piece handle using a polypropylene-bacteriostat mixture. The bacteriostat, Biozel®, inhibits the growth of bacteria and odor-causing germs and resists mildew and mold . . . a big selling plus with housewives. Biozel is non-toxic and non-irritating to the skin. Tests indicate that its effectiveness continues for a year and longer.

Polypropylene was selected for the handle because of its strength, light weight and flexibility. These properties enabled CMPC to mold a small strap, used to fasten the mop attachment, as an integral part. Thus, the handle is strong and flexible—will bend around curves without breaking and it has no sharp edges to scratch surfaces being cleaned.

Perhaps these same advantages can be applied to your product. A call to your Chicago Molded Sales Engineer will bring you the services of an experienced and trained plastics specialist. Or write:

Send for new brochure "Design and Purchase of Custom Molded Plastics."

CMPC

CHICAGO MOLDED PRODUCTS CORPORATION
1020 H North Kolmar Avenue
Chicago 51, Illinois

THE PLASTISCOPE

Another ethylene copolymer

Elvax is a new vinyl acetate-ethylene copolymer by Du Pont. It is said to impart toughness, flexibility, and adhesion to paraffin wax and other brittle low-molecular-weight materials. These resins are expected to increase the use of wax in paper, packaging, and adhesives. When 30% or more is used in the wax blend, the mixture behaves more like a polymer than a wax. Coatings containing Elvax can be bonded to foil, waxed paper, PE, cellophane, and Mylar.

Here is another interesting little item that "makes the cheese more binding," as our fathers used to say. Several years ago it was reported that a wax shortage was inevitable. Said a Du Pont man: "Oh, shucks—with all this polyethylene around we won't need any more wax." He was referring primarily to PE coatings and film. Since then there have been many items introduced to upgrade wax. There have also been Epolene, AC-6, and other low-molecular-weight polyethylenes for coating on paper; and there have been PE extrusion compounds and film laminates. Spencer has just announced a polyethylene latex that can also be used for similar purposes. The producers, of course, say each has its own field. But how many fields can there be? Pity the paper coater technician who has to know all about all these and other plastics materials when his boss asks for the score.

More polyethylene by Du Pont

Two new high-pressure polyethylene plants by Du Pont to be completed in the third quarter of 1962 will bring its total PE capacity (including low-pressure) to nearly 400 million pounds. The new plant is expected to satisfy company demand for Elvax PE film (mentioned above) and a variety of new polymers. In the meantime, Du Pont has made arrangements to purchase polypropylene from Hercules for limited sales and internal consumption, as part of a market development for future polypropylene production.

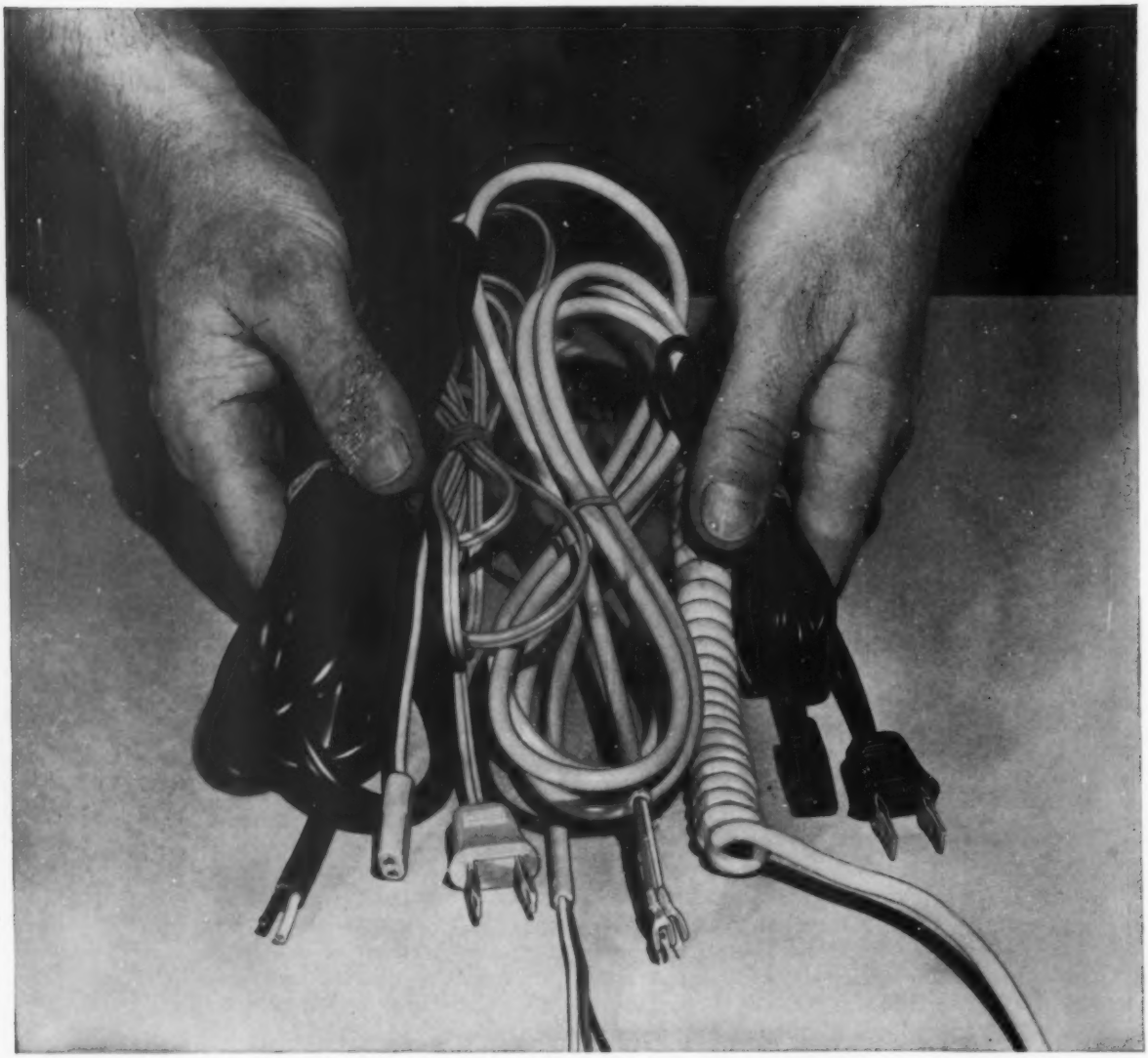
At the recent Chemical Market Research Assn. meeting in New York, J. B. Knowles, sales manager of plastics of Union Carbide, said that industry-wide capacity for PE had grown from 450 million lb. in 1957 to 1.7 billion lb. in 1960, with sales rising from 350 million to 1.2 billion during that period. And now comes Du Pont with a lot more capacity!

Du Pont also announced a new black PE resin for extrusion coating with 2½% carbon black for improved weatherability. Its base density is 0.923, its melt index is 3.7. It is suggested in paper-polyethylene combinations for construction and agriculture.

Acrylic film-forming resin

Carboset 511 is the name of a new water solution of an acrylic polymer that dries at room temperature to a clear, tough, glossy, water-insoluble film introduced by B. F. Goodrich Chem. Co. The resin is normally supplied in a 45% water solution, but it is also available in an alcohol solution for use in aerosol hair sprays. The material is a protective coating rather than a sheet, and should not be confused with strip-coats that peel off. It may be applied by brush, dip, or spray methods.

Carboset 511 films are said to adhere well to metal, glass, paper, leather, Mylar, PE, and vinyl films. One outstanding feature is that they are



Need a quality resin accepted and approved for electrical applications?

VYGEN 120 PVC resin is UL-approved as interchangeable with other quality PVC resins for wire insulating applications. VYGEN 120 is specially formulated for fast economical dry-blend extruding, with monomeric or polymeric plasticizers. It assures a lack of gelled particles... provides excellent heat and light stability plus exceptionally long life. See how VYGEN can help your products... speed your production... send for complete technical literature today!

VYGEN®

VYGEN 85 — Recommended for calendering, extrusion and molding operations where processing at low temperatures is desired.

VYGEN 105 — For light-embossed sheeting and for molded items and extrusions requiring high gloss finish.

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Chemicals for the rubber, paint, paper, textile, plastics and other industries: **GENTRO SBR** *rubber* **GENTRO-JET** *black masterbatch* • **GEN-FLO** *styrene-butadiene latices* • **GEN-TAC** *vinyl pyridine latex* **GENTHANE** *polyurethane elastomer* • **ACRI-FLO** *styrene-acrylic latices* • **VYGEN PVC** *resins* • **KURE-BLEND** TMTD *masterbatch* • **KO-BLEND** *insoluble sulfur masterbatch*

resistant to even boiling water, yet thin films can be removed with soap and water (thicker films can be removed with dilute bases).

The resin is compatible with water dispersions of most polymers, and even in small quantities will permit modification of dispersion and solution coating materials, such as styrene-butadiene and those containing acetone or methyl-ethyl-ketone.

Used at low concentrations in floor wax, it provides protection but also permits removal of the wax when the floor becomes dirty or stained and a fresh coat of wax is desired. In addition, it improves leveling and gloss of the wax. The resin could be suitable as a clay binder in paper coatings or as a protective coating for metal that can be washed off with a mild alkali. In the hair spray mentioned above, its moisture vapor transmission is so efficient that it protects the hair, yet can be washed off with shampoo. This is a most curious material. It resists water, yet can be washed off with soap and water. Experimenters are going to have a lot of fun finding all sorts of uses for it.

PVC sheet to withstand boiling

Seiberling Rubber Co. is now producing a corrosion-resistant PVC sheet that reportedly will withstand boiling water, or about 60° F. higher than standard vinyl. It is made from B. F. Goodrich Chemical Co.'s hi-temp PVC, furnished in both normal and high-impact grades. It is suggested for ductwork and tanks for industries handling strong acids and very hot corrosive liquids. The sheets come in 4- by 8-ft. sizes and thicknesses from 1/16 to 1 inch.

Round-the-world in plastics

A round-the-world visitor from Australia who recently dropped in for a visit apparently sees everything. Here are a few of the items he brought us for brief mention. Some of them are known, others almost unknown, in the U. S.

Englishmen and Australians do *not* use much high-density PE in bottles—not even detergent bottles. In these two countries at least, they use ICI's X-DK10, with an 0.923 density (or perhaps less) and a melt index of 0.50, which gives a comparatively hard surface. They still like the "squeeze" effect.

An extruded, ribbed PVC, 3 ft. wide, is used for bus flooring in Italy. Another Italian use is covering rattan with PVC for chairs.

Some 2000 tons of PVC are used annually in Australia for injection-molded shoes for youngsters and workmen. The shoes are about one-sixteenth the price of leather shoes.

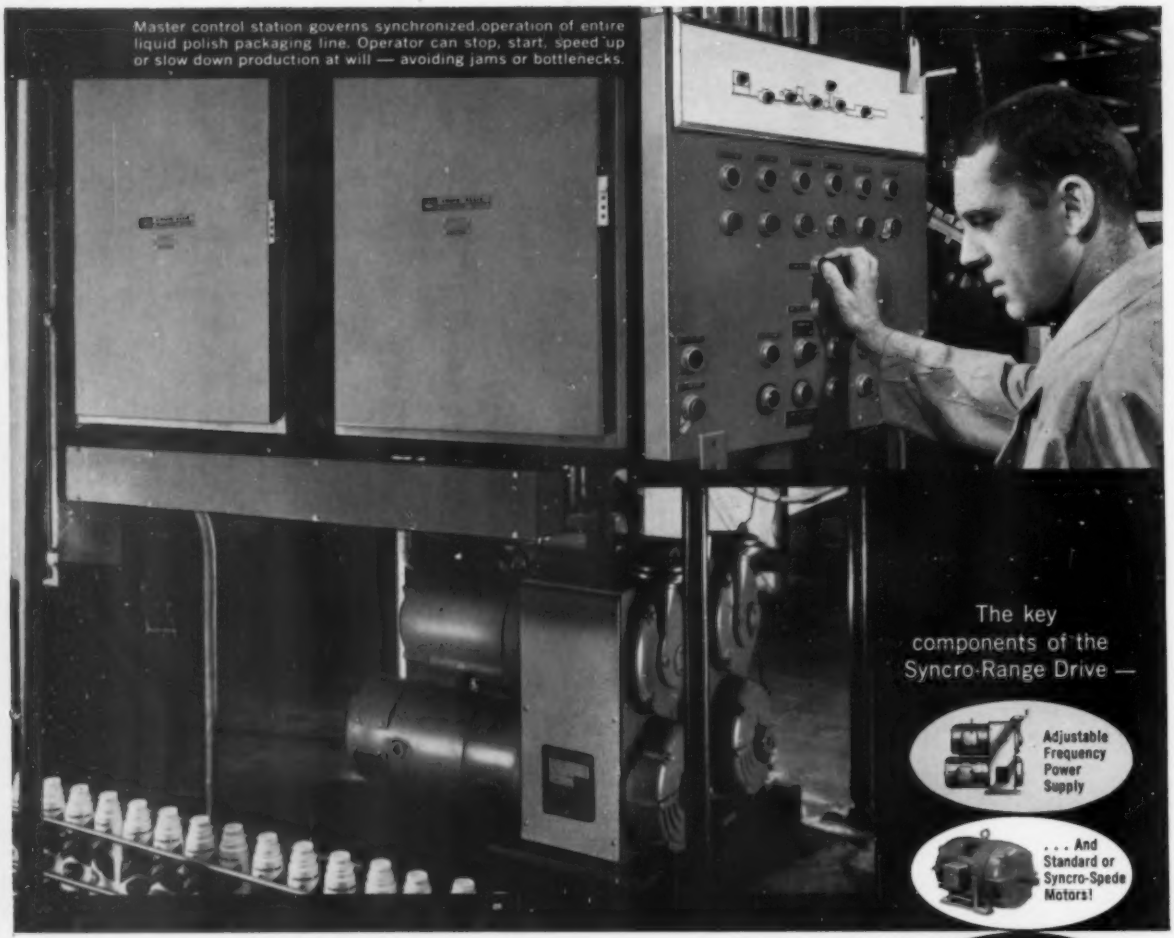
Injection-molded PVC soil pipe fittings, gutters, and drain pipes are being produced in Leeds, England.

In Italy there is a blown vinyl chloride shoe sole molded directly onto a leather upper.

Fifteen machines are said to be operating 6 days a week in Italy on a PVC window shutter that is fitted to rollers that move it up or down.

An English firm is metallizing 5-mil rigid PVC calendered film by Kalle of Germany for trays in boxed candies. One customer bought 1½ million of them. Costs more than paper, but provides labor savings during packing.

Australians have been extruding PE over metal pipe for 2 years for corrosion resistance. (*Ed. note.* Same thing has been going on in this country


Master control station governs synchronized operation of entire liquid polish packaging line. Operator can stop, start, speed up or slow down production at will — avoiding jams or bottlenecks.
The key components of the Syncro-Range Drive —
Adjustable Frequency Power Supply
. . . And Standard or Syncro-Spede Motors!

LOUIS ALLIS SYNCRO-RANGE DRIVES automate liquid polish lines

Johnson's Wax, renowned wax and polish producer, uses Syncro-Range Drives for exact control of process lines

Controlling the speed of the precise, mass-production lines for their new, highly successful liquid shoe polish was the task Louis Allis engineers had to solve for Johnson's Wax.

The problem was to time the flow of plastic bottles, liquid polish, wool daubers, and caps into the packaging lines at precisely equal rates. Flow rate must be adjustable so the lines can be slowed down or speeded up. And the entire packaging operation must be controllable from a single master control. The Louis Allis Syncro-Range Drive solved the problem.

Syncro-Range Drive provides synchronized speed of any number of motors from a single control. It is a "packaged system" comprising an adjustable frequency power supply operating on 3 phase, 60 cycle power input . . . a group of Syncro-Spede® synchronous motors which maintain exact synchronism regardless of varying load . . . and a control which permits the speed of the entire group of motors to be simply adjusted without losing synchronization. On applications for which exact synchronism is not required, standard squirrel cage motors can be supplied.

You can readily see the advantages of the Syncro-Range Drive in systems or processes which require synchronized movement: multiple conveyors which feed consecutively; transfer lines; process lines; assembly lines requiring coordinated arrival of components; printing where one press feeds another; synthetic fibre spinning, drawing, or twisting; metal runout tables; and other similar machines which require the application of power at a number of points on the machine.

The Syncro-Range Drive is available with a choice of drive sizes to efficiently control from 2 to 200 motors. Control features are available to provide speed regulation accurate to 0.1% with 0% relative speed difference between motors! A trained Louis Allis motor application engineer is available to help. You can reach him at your local Louis Allis District Office, or by writing to The Louis Allis Company, 470 East Stewart Street, Milwaukee 1, Wisconsin.

A59-232

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

for several years with Koppers high-density resin on pipe ranging from 1- to 10-in. diameter.)

The Japanese are producing a clear vinyl-wire-vinyl laminate to compete with reinforced polyester-glass—one company is said to be using 1000 tons of resin a month for this purpose.

Polyether vs. polyester for urethane foam

Eight tank cars built with polyether urethane foam to provide insulation represent one of the latest triumphs of rigid urethane. Atlas Chemical Products proudly points to use of its polyether in this significant development. The Atlas polyether is derived from sorbitol and thus takes the lead as the first major plastics product derived from sugar. Atlas is a leading supplier of polyether for rigid foam.

Polyether-urethane foam for rigids is hardly a year old. Its first big use was reportedly in submarines. One large refrigerator manufacturer is now reportedly converted 30% to rigid urethane and another to 15%—others are reportedly on the way. Reefer trucks are another convert to urethane.

Polyester is still widely used in rigid urethane foam, although its higher cost in contrast to polyether may check its growth. Polyester has lost out in most flexible foam uses except for inner linings of outer garments, where it is claimed that polyester can be peeled thinner than polyether without leaving holes and that it will also withstand dry cleaning.

Over-capacity in urethane foam

Suppliers of materials for urethane foam are worried about the considerable over-capacity now available for the flexible variety. In 1960, estimated consumption was from 85 to 90 million lb. for flexible and 10 or 11 million lb. for rigid. The 1961 estimate is at least 125 million lb. for flexible and 16 million lb. for rigid. The 1965 estimates for flexible range from 200 to 350 million lb. and 115 to 150 million lb. for rigid. There is said to be enough capacity now to make perhaps 1 billion lb. of foam. This over-capacity situation is not new to plastics, but this one is probably the worst ever and can only lead to trouble. In fact there are several producers who alone could turn out all the foam needed today. Some plants can make from 2 to 3 million cu. ft. in one shift. Evil factors in such a situation always lead to price wars, to degradation of the product by processors who are hard-pressed by competition, to poor financing and poor credit risks. Already there are signs of lowering densities from 2.2 to 1.4, or even 1.1, when it isn't practical.

Even development of the most promising markets is not expected to absorb such a huge volume of flexible foam. The ultimate by 1965 could hardly be more than 125 million lb. for furniture from its present 60 million lb.—refrigerators might use 50 million lb., and even if all autos used 30 lb. per car it would still be a piddling amount of that billion lb. capacity.

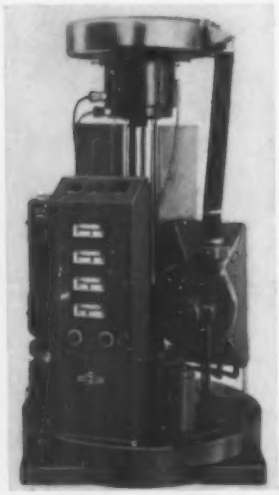
An odd facet of this over-capacity for foam is that there isn't near enough capacity for slicing and peeling the buns. Apparently there are only a very few processors who have learned how to handle this operation without extreme waste or damaged goods.

For additional and more detailed news see Section 2, starting on p. 212

NEW MACHINERY-EQUIPMENT

Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.*

Vertical extruder for blown film



The Rotatruder, designed for the production of blown film, consists of a vertical screw and barrel which extrude the melt upward while rotating slowly around the barrel's axis during operation. Rotation of the extrudate output results in the ability to wind the film more evenly and efficiently on the take-off reels. The unit includes a cooling ring, cooling air blower and exhaust, and a control unit. The entire cooling system rotates with the unit. Screws are cored for cooling. Dies are threaded and screwed directly into the extruder barrel. Through elimination of elbows and adapters, chances for material hang-up are minimized. Barrel and die are electrically heated and temperature is controlled by photo regulators. Two models are available: a 40-mm. (1.57-in.) screw with an L/D ratio of 15 or 20 for tubular film 2 to 20 in. wide, and a 60-mm. (2.36-in.) screw in the same L/D ratios for film 10 to 47 in. wide. Maximum extrusion rates are about 40 to 100 lb./hr., respectively. Unit is designed for processing materials such as polyethylene, polypropylene, nylon, and PVC. *Zürich-Oerlikon, Birchstr, 230, Zurich, Switzerland.*

Foam paring machine

The Femco circumferential foam paring machine is used to convert foam logs into semi-continuous sheets of foam. The foam log is automatically rotated into the unit's cutting head in such a way that a continuous sheet of foam is pared or peeled from the log. The pared sheet is then wound up on paper cores 2 or 3 in. in diameter. Foam sheets as thin as 1/32 in. can be made. Thickness is changed in 5 min. or less by changing lead screws in the cutting head. Logs up to 84 in. wide and 48 in. in diameter can be fed. If foam log feed is square, machine trims the square log to a round shape before paring. Cutting speed of the unit is variable from 1 to 350 ft./min. while cutting. Provision is also made to wind stock without stretching. *Falls Engineering & Machine Co., 1734 Front St., Cuyahoga Falls, Ohio.*

Vibrating feeder

Suitable for the feeding of dry powders, such as vinyl dry blends, to processing machines, the Vibra Screw Live Bin Feeder maintains a metering accuracy better than 1% and feeds materials without bridging or flooding. Also useful for metering additives to plastic materials as they are being fed, the unit has a 3-cu.-ft. vibrating hopper which can be enlarged to 5 or 8 cu. ft. without loss of effectiveness. The contents of the hopper are conducted to the processing machine by a vibrating screw; screw sizes from ¼ to 4 in. are available with resultant unit capacities of 0.003 to 200 cu. ft./hr., respectively. Screws up to 2 in. use a ⅓-hp. drive motor; 3- and 4-in. screws are interchangeable and are driven by a ½-hp. motor. Screw speed is variable with a 10:1 speed range to change the feed rate. *Vibra Screw Feeders Inc., Clifton, N. J.*

Resin system

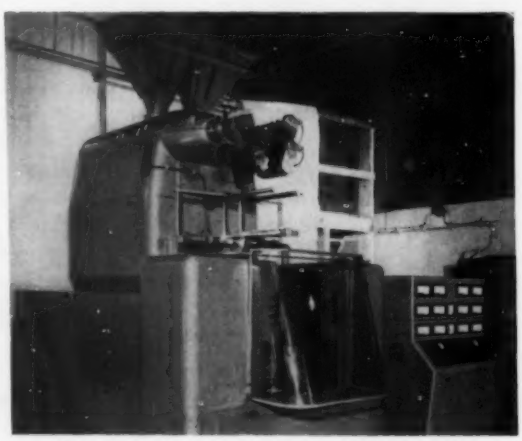
Called Duo-Flo and designed for continuous pumping, metering, and applying flowable two-part compounds, the equipment can accurately meter a wide range of two-part compounds of 0 to 20,000 c.p.s. viscosity, including epoxies, polyurethanes, polyesters, and foams. Sprays or flows from the gun emerge thoroughly mixed. Features of the new equipment include high volume capacity, internal mixing, adjustable spray range, and adaptability to 55-gal. drums. The unit is portable and simple to clean. *Pyles Industries Inc., 20855 Telegraph Rd., Detroit 41, Mich.*

Plastic box printer

The Model 70AB machine will automatically print flat plastic surfaces on boxes and other parts; one-color imprints as large as 2 by 3 in. can be made at a speed of about 3600 pieces per hour. Either manual or automatic feeding may be used; part ejection is automatic. Quick-changing printing type is used to minimize changeover delays. *Markem Machine Co., Keene, N. H.*

Two-color blow molder

Designated Model V 18 Z, this specially designed blow-molding unit has two separate extrusion screws and barrels mounted on a single base and fed from two separate hoppers. Each extruder head is fitted with sheet or ribbon die. A sheet of different color is produced in each die. The sheets are then fed over guides to appropriate positions between the molds. As the molds close the different colored sheets are clamped together and air is introduced between the sheets, blowing a two-colored part with the color demarcation along the parting line of the mold. An important extra in the machine is the ability

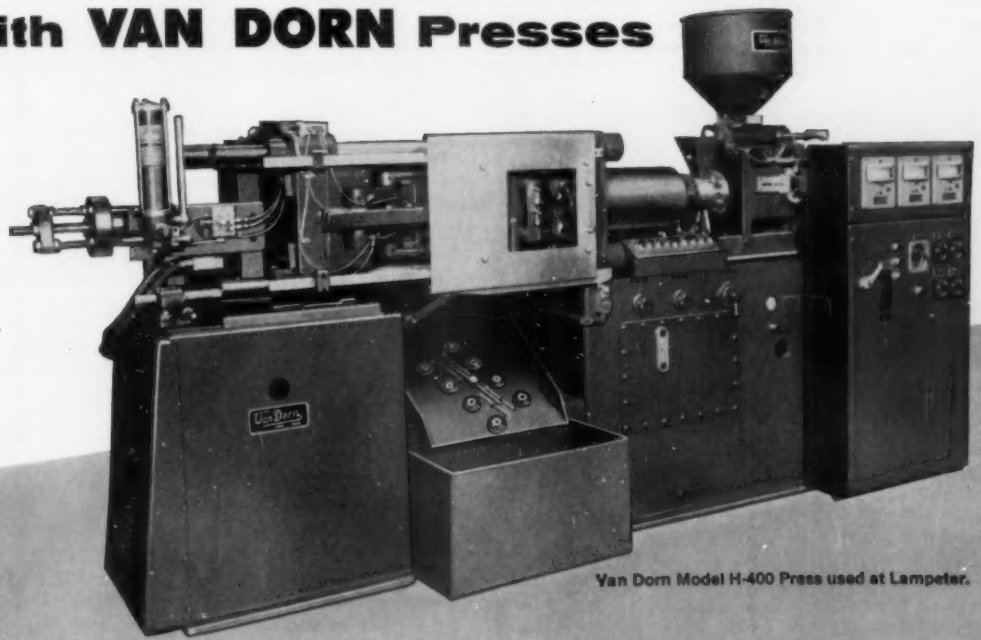


* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of **Modern Plastics** do not warrant and do not assume any responsibility whatsoever for the correctness of the same or otherwise.

Hubley Tic Toy Clock—many of the 40 parts are made on The Lampeter Manufacturing Company's Van Dorns.

tic tock, 'round the clock

AUTOMATION with VAN DORN Presses



Van Dorn Model H-400 Press used at Lampeter.

As a major supplier for The Hubley Manufacturing Company, a leading toy producer, The Lampeter Manufacturing Company is an extensive user of plastic machinery. Lampeter operates their fully automatic Van Dorn 4-6 oz. and Van Dorn 3 oz. presses *24 hours a day, six days per week.*

Besides a substantial reduction of cycle time, the company reports the Van Dorn presses are economical, versatile, and require minimum maintenance. The general manager says that if he buys more machines of the same size, Van Dorns would certainly be a top consideration.

You, too, can save time and money with Van Dorn high production injection presses. Write for detailed information.

Inspection of toy parts produced on the Van Dorn H-300.

Van Dorn

THE VAN DORN IRON WORKS CO.

2685 East 79th Street • Cleveland 4, Ohio

Sales and Service Nationwide In Canada: B. J. Danson & Assoc., Ltd., Toronto, Ontario

to blow mold flat-shaped parts. Furthermore, the twin-extruder machine can be used in conventional fashion to simultaneously extrude tubular parisons in single color work. *Kautex Machines Inc., 536 E. Elizabeth Ave., Linden, N. J.*

Screw preplasticator attachments

These extrusion-screw plasticating units are designed for the conversion of conventional injection systems into preplasticator systems. Suitable for use with Battenfeld machines, they may also be adapted to any other make

machines with shot capacities of from 1 oz. to 22 pounds. Preplasticator screws with L/D ratios from 18:1 to 24:1 are available. Not to be confused with reciprocating-screw injection units, these preplasticators may be mounted above or on the side of conventional ram cylinders to deliver fully plasticated melt to the main cylinder for injection. Design of the units is such as to permit quick screw changes if required for cleanout or replacement of the screw with another. *Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Ill.*

Hopper loader

Bucketlift Jr. is a low-cost, compact bucket elevator designed for the automatic loading of injection molding and extruder machine hoppers. The inlet hopper is 25½ in. above floor level. Material can be conveyed to heights up to 30 ft. at rates up to 15,000 lb. per hour. Unit is available with steel, aluminum, or stainless steel housings and buckets. Sections 2½, 5, and 10 ft. long can be used to make various elevator lengths up to 30 feet. Special hoppers, drive units, portable bases, and other variations are also offered. *M-H Standard Corp., 515 Communipaw Ave., Jersey City 4, N. J.*

Cut-off saw

The Tri-Rail panel saw is an addition to the Hendrick MLR-P and MA-P line of panel saws for cutting sheet plastics. Stock up to 14 ft. wide can be cut and the saw provides for cutting bevels by tilting from 90 to 45°. Both manual and automatic saw travel models are available. Saw is raised and lowered by means of a handwheel. A 3-in. steel tube has been added to insure more rigid construction and more accurate guiding of the saw for precision cutting. *Hendrick Mfg. Corp., Marblehead, Mass.*

Bag tester

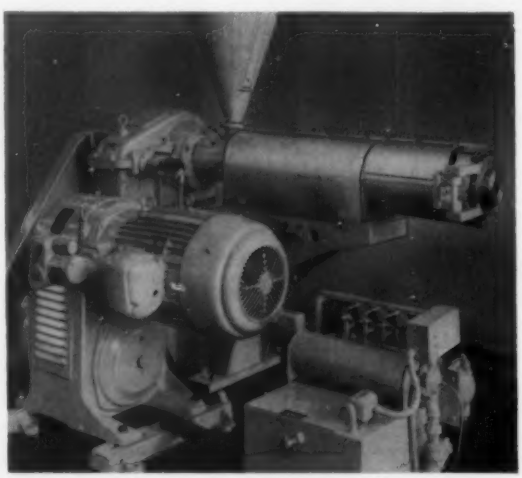
Originally developed for testing the burst strength of Mylar bags, this pneumatic bag tester (Catalog No. 34) can be set to apply either an impact type of load or the air pressure can be built up slowly within the bag to test the peel strength of seams. An air supply of about 100 p.s.i. is all that is needed to power the machine. To test a bag, it is fastened to the outlet of the machine. Then as air is admitted in rapid or slow fashion, a pressure-gage calibrated in in. of water reads the air pressure. A follower on the pointer records the pressure at failure of the bag. Total range of pressure which can be measured ranges from 0 to 160 in. of water (0 to 5.8 p.s.i.) and its use is said to be limited to bag constructions as well as to materials which will fail below the maximum pressure of the instrument. *Sunshine Scientific Instrument Co., 1810 Grant Ave., Philadelphia, Pa.*

Extrusion pressure indicator

This Model I-S86 pressure-indicating system consists of a precisely regulated voltage supply which is designed for use with a strain gage pressure transducer with four active arms. The output of the transducer is fed to a low-current, high-resistance indicating meter with a scale calibrated in pressure units. As pressure changes, the meter input changes accordingly. An integral push-button calibration system is included for matching the instrument to the transducer to adjust the dial range, allowing full interchangeability of transducers. Standard pressure scale ranges are 0 to 3000 p.s.i., 0 to 5000 p.s.i., 0 to 7500 p.s.i., and 0 to 10,000 p.s.i. Supply voltage is 120 v., 50/60 cycle only. *West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.*

Induction-heated extruders

Called the Model 150 line, these four Aetna-Standard extruders, with screw sizes ranging from 2½ to 6 in., are rated for pressures up to 5000 p.s.i. and have 3-, 4-, or 5-zone, induction heated cylinders, which are supplied with or without air cooling (water cooling optional). Typical production rates range from 75 to 700 lb./hr. of polyethylene (Sp. Gr. = 0.92, M.I. = 2) at 400 to 600 ° F. and a head pressure of 2000 p.s.i., depending on the size

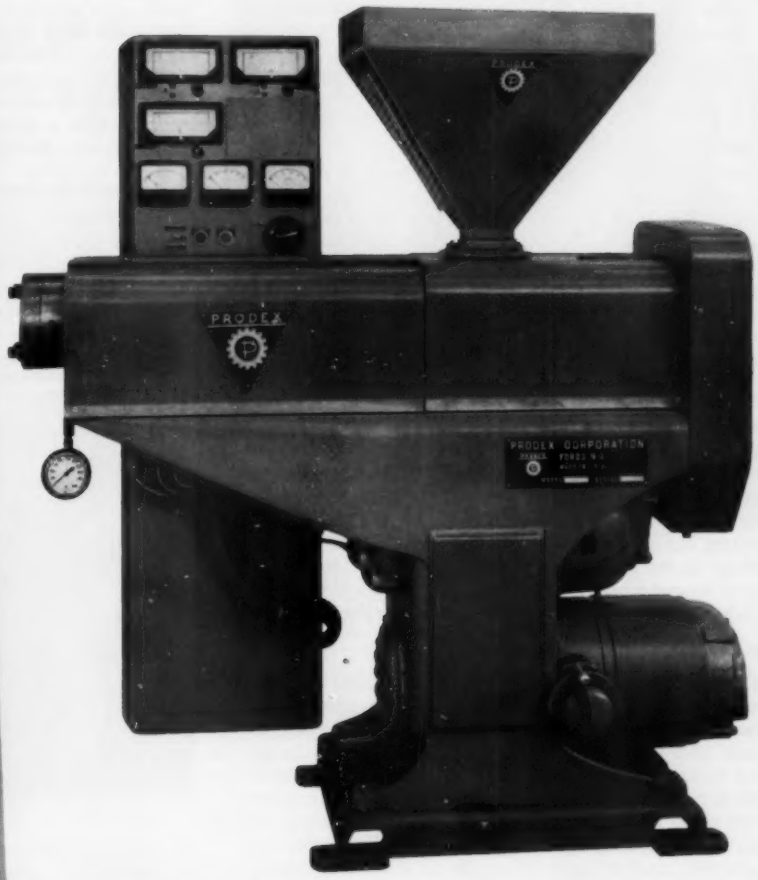


of the extruder. The units are designed for service in applications which do not require valved pressure control. All models have a double-reduction herringbone transmission with a rated efficiency of 96 percent. Tapered roller, radial-thrust bearings are used, which have an LB-10 life of 10,000 hr. at 100 r.p.m. and 5000 p.s.i. pressure;

PRICED TO REALLY COMPETE

OUTPUT RATES:
50—150 lbs/hr

L/D RATIOS:
20:1 and 24:1



the new

PRODEX COMPACT EXTRUDER

QUALITY FEATURES INCLUDE

- Heavy integral machine/motor base requiring half the space needed before.
- Alloy steel screw. Screw flights hard surfaced with Stellite (not flame hardened). They maintain their hardness, Rockwell C55, through highest extrusion temperatures.
- One-piece heavy wall cylinder Xaloy-lined.
- Thrust assembly with self-aligning spherical roller thrust bearing, large inspection window and circulating oil lubrication system.
- Large rectangular feed opening.
- Swing gate for easy die mounting.
- Automatic temperature control.
- Efficient air cooling.
- Full instrumentation, including screw speed indicator, melt temperature indicator and motor load ammeter.
- Continuously adjustable speed range 4.5 to 1.
- Completely prewired ready to run.

See the Prodex Compact perform with your own materials in our Customer Service Laboratory. Phone or write for an appointment or literature.

PRODEX
—in design and performance
ALWAYS A YEAR AHEAD

PRODEX CORPORATION
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hoppers are water cooled. All units have flame-hardened, chrome-plated screws and alloy steel barrels with Xaloy linings. All have L/D ratios of 20:1 and the standard screw-speed range is 10 to 75 r.p.m. (can be varied to suit requirements). *The Black-Clawson Co., Hale and Kullgren Plastics Dept., 613 E. Tallmadge Ave., Akron 10, Ohio.*

Foaming machine

This unit is designed to produce a full range of polyether, polyester, dimer base, or halogenated hydrocarbon foams, either flexible, rigid, or semi-rigid in a range of desired densities at rates of up to 200 lb. per minute. It is available with equipment to handle two, three, or four components, and standard equipment includes an automatic mixing head for determined mold fills or for continuous operation. *Gabriel Williams Co. Inc., 77 Mill Rd., Freeport, N. Y.*

Plasticity tester

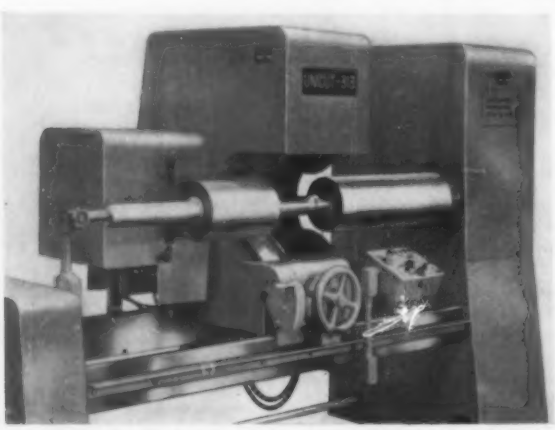
Designed for the study of the high-temperature processing properties of plastic materials, the C. W. B. Plasticorder is said to accurately forecast and record the plastic properties of the material to 1150° F. Used in conjunction with the C. W. B. Plastograph, a measuring head with a vertical mixing chamber and shaft operates within a tube furnace, which allows experiments to be conducted at constant or programmed temperature cycles between 575 and 1150° F. *C. W. Brabender Instruments Inc., South Hackensack, N. J.*

Vacuum former

The Tronomatic Jr. machine has been designed to meet moderate production requirements in the fabrication of vacuum-formed objects and blister packs. Using a roll feed, 22-in.-wide plastic material is drawn into the clamping frame and the heater is moved into forming position. When heating is complete, the heater is swung back and a foot pedal causes the mold to rise and apply vacuum to draw the plastic around the mold. Removal of the formed part pulls another length of continuous sheet into position for the next cycle. Machine may be automated with accessory equipment. A drape table may be substituted for the mold for blister packaging. *Tronomatic Machine Mfg. Corp., 25 Bruckner Blvd., Bronx 54, N. Y.*

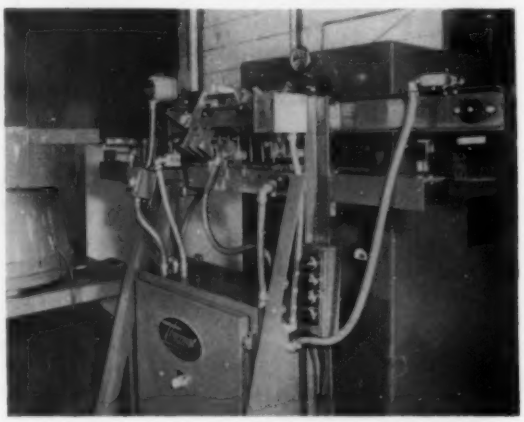
Roll cutter eliminates rewinding

Called the Unicut-313, this machine will cut rolls of film into reels of various widths without rewinding of the roll. Unit has top and bottom knives which rough and trim the material to finished reels with smooth edges free from flagging. Individual knife drives allow the speed of each knife to be adjusted independently to allow for running differential knife speeds. Roll rotation speed is also variable. Cutting stroke speed is adjustable from 5 to 30 sec. per stroke. Adjustable stroke drive allows knives to adjust for cutting pressure and "feel" their way through the roll. Machine is powered by five motors. *Oscar I. Judelshon Inc., 404 Tonnele Ave., Jersey City 6, N. J.*



Automatic preheater

In this Thermex equipment, preforms are loaded into a vibratory feeder, where they are then automatically indexed and loaded into the preheater for raising to processing temperature under automatically controlled high-frequency heating cycles, and then automatically fed to the transfer pot of the molding press. Typical complete cycles



are as short as 18 seconds. Automatic interlocks prevent delivery of the preform to the press until the press is ready to accept the charge. Rectangular preforms up to 3 by 4 in., and 1¼ in. thick, can be handled. A complete 18-sec. cycle for a load of four 150-g. general purpose phenolic preforms consists of: a preheat of 12 sec., delay of 6 sec. for timing, including 3 sec. for delivery to the press and 3 sec. for preform loading into the heater. *Girdler Process Equipment Div., Chemetron Corp., 334 E. Broadway, Louisville 1, Ky.*

Heated hose

Designed for conveying plastic melts and resins which are too viscous to flow at room temperature, this electrically heated, Teflon-lined hose can be adapted for use with valves, nozzles, and spray guns. Shielded with an outer stainless steel braid, the hose may be used with gravity flow systems or with pressurized tanks and pumping systems. Unit comes with power supply for the hose heaters; power source is a variable-voltage, step-down transformer with a primary for 115- or 230-v. single-phase inputs. Metal and synthetic rubber hose linings are also available. *Sta-Warm Electric Co., Ravenna, Ohio.*

Underwater pelletizer

Suitable for use with a wide range of thermoplastic materials, the Hartig underwater pelletizer can be used with extruders ranging in size from 2½ to 12 inches. In underwater pelletization, the strands of material are cut as they issue from the strand die, which is located under the surface of a water bath. Advantages include the production

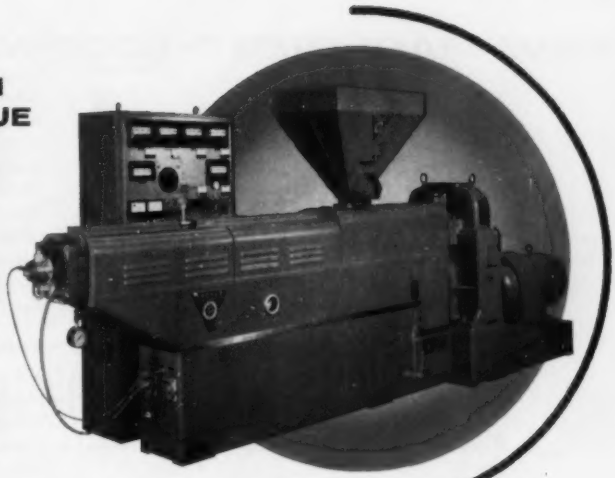
Years Ahead!

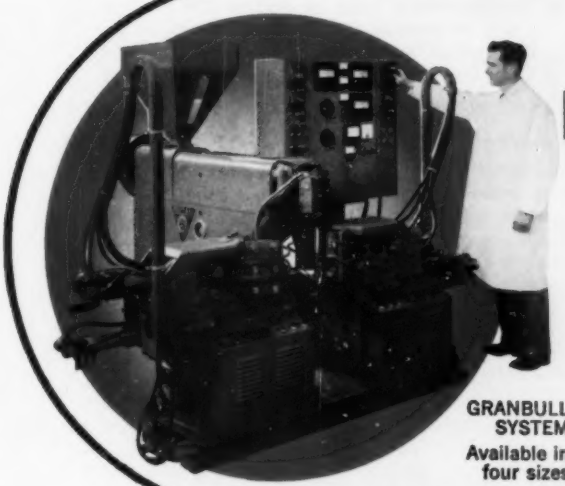
PRODEX HIGH TORQUE EXTRUDERS

with CHANGE GEARS

now permit you to select quickly the optimum reduction ratio and screw speed necessary to extrude **either high or low viscosity materials** at maximum horsepower efficiency and highest possible production rate for each extrusion job.

Prodex extruders give you the best possible machine return on your investment of any extruders in the world today. These machines are built vented or non-vented in a complete range from 1¾" to 10".





GRANBULL SYSTEM
Available in four sizes

PRODEX FULLY AUTOMATIC BLOW MOLDERS

For small parts—up to 2 gal.—a toggle clamp mechanism is used to develop high pressures and high speed action. A continuous parison flow from a single head feeds up to four mold clamps, resulting in extreme uniformity of parts. The highly streamlined head permits use with all polymers, including rigid PVC.

For large parts—5 to 55 gal.—an accumulator system allows fast extrusion of large parisons, with precise shot metering and uniform temperature throughout the parison prior to blowing.

Prodex blow molders, for maximum output and reliability of operation, are supplied with specially designed, high-performance **Prodex extruders.**

THE REVOLUTIONARY

PRODEX MIXERS

(HENSCHEL SYSTEM) U. S. Pat. No. 2,945,634

FOR INTENSIVE

Resin Dryblending • Pigment Dispersion • Mechanical Heating • Vacuum Drying of resins and compounds in EXTREMELY SHORT CYCLES WITH EXCELLENT UNIFORMITY!

Both laboratory and high production units are now available with capacities from a few lbs. to thousands of lbs./hr. • They can be cleaned quickly and easily. • All contacting surfaces are stainless steel. • Vacuum tight construction is available for vacuum extraction. • Loads and discharges while running.

Available in four sizes

See PRODEX extruders, blow molders and mixers perform with your own materials in our **customer service laboratory.** Write or call for an appointment.

PRODEX
—in design and performance
ALWAYS A YEAR AHEAD

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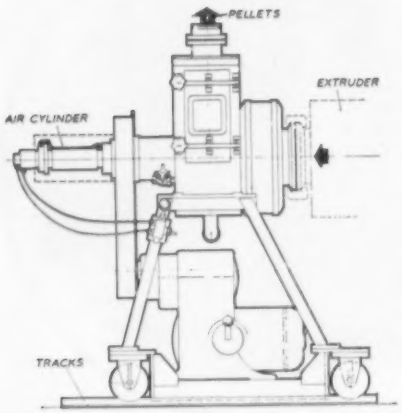
NEW MACHINERY-EQUIPMENT (From page 48)



of a pelletized material of low bulk, density free from fines, the minimization of oxidation of the material, and the elimination of material fumes. Complete package includes the basic pelletizer head (including die body and plate), a water circulation pump, temperature-controlled water reservoir, vibrating-screen separator, air heater, blower, cyclone separator, and auxiliary duct work, for pellet drying and separation system. Typical outputs range from 100 to 7000 lb./hr., depending on extruder output. *Waldron-Hartig Division, Midland-Ross Corp., Box 531, Westfield, N. J.*

Platen service

Adamson United is offering a new and substantially less expensive service in platen manufacturing through the use of a fully automatic deep-hole drilling machine designed and built in their own plant. The new drill, along with other machinery, produces platens ranging in size from 12 in. square up to 120 in. wide by 40 ft. long. It also produces more accurately dimensioned cooling channels, which are said to improve the uniformity of heat transfer within the platen. *Adamson United Co., 730 Carroll St., Akron 4, Ohio.*

Potentiometer

Newly designed, the Model No. 1331-HG Quick Check potentiometer can be used for checking mold surface temperatures. Accuracy of the instrument is said to be 0.5 percent. The instrument can be used to measure temperatures from —300 to 3000° F., and is supplied with an automatic reference junction and interchangeable thermocouples. The unit is available in either hand or table top models ranging in price from $80 to $109.50. *Pyrometer Service Co. Inc., 348 River Rd., N. Arlington, N. J.*

Ultrasonic sealing unit

A new ultrasonic sealing device has been developed for the sealing of such films as polyethylene terphthalate, polyvinylidene chloride, etc. The device will be sold to manufacturers of packaging and sealing equipment. Films 0.001 to 0.020 in. thick can be sealed to each other in multiple layers and to other materials, such as fabric. Sealing speeds up to 222 ft./min. are possible. *Powertron Ultrasonics Corp., Patterson Pl., Roosevelt Field, Garden City, N. Y.*

Cut-off saw

Designed for cutting rigid extruded plastic materials in line with the extruder, this automatic traveling saw will handle any cross-section extrudate with the maximum dimension up to 7 inches. Linear accuracy of the cut is within 0.005 inch. Surface table height can be adjusted in stepless fashion to suit the extruder output height. Maximum travel of the saw is 35 inches. Cutting blades up to 18 in. in diameter can be used, and a saw drive shaft extension makes it possible to drive the saw off the take-off drive or variable speed drives, which are separate units. All table and saw movements are air actuated; table feed is adjustable with a needle valve. *Progressive Machine Co. Inc., 198-202 E. 25th St., Paterson 4, N. J.*

Dynamic tester

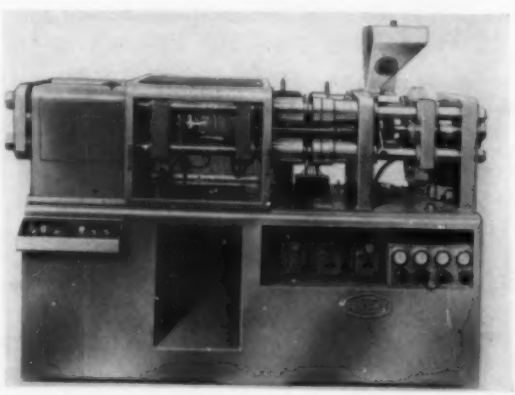
For the study of the dynamic mechanical properties of plastics, the TMI Maxwell instrument (designed by Prof. Bryce Maxwell of Princeton University) applies a sinusoidally oscillating strain to the test specimen. The magnitude of the strain can be controlled to study any desired portion of the stress strain curve of the material. The machine includes an environmental chamber for studies over the temperature range of —40 to 200° C. Test frequency may be adjusted from 0.001 to 300 cycles per second. Test method description will be found in ASTM Bulletin 215, available from the manufacturer. *Testing Machines Inc., 72 Jericho Tnpke., Mineola, N. Y.*

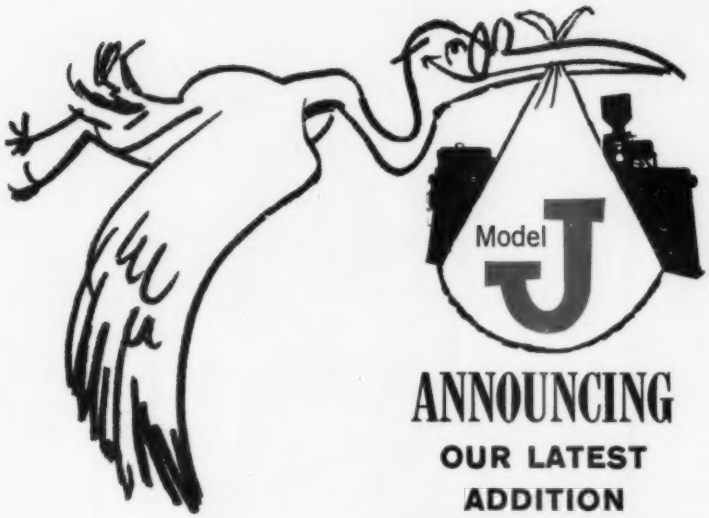
Tube marker

The Model AC-1 is designed to imprint polyethylene tubing as it comes from the extruder and is being spooled. The machine will mark up to 50 ft./min. of tubing and will handle piping from ¾ in. to 4½ in. in outer diameter. The unit can be disengaged at any time by stopping the variable-speed drive. The engraved roller is designed to make imprints up to 1 ft. long. *Ackerman-Gould Co. Inc., 10 Neil Court, Oceanside, N. Y.*

Injection machines

The Dowding Universal injection molder is rated at 2 oz. of polystyrene and is designed with a reciprocating-screw plastication system. The injection screw is driven by a variable speed hydraulic motor with overload relief valve, the motion being transmitted to the screw by gears mounted with anti-friction bearings. Two hydraulic pumps are used: one for the screw drive, the other for clamping and injection. Heating cylinder has four heater bands in two zones, with West temperature controls. A rotary switch can be set for automatic or single cycle, or inching. Timers have a range of 2.5 to 68 seconds. Special care has been used to make the screw and nozzles easy to remove for cleaning. Both ejector bar and stroke are adjustable. Maximum mold size is 12 by 10⅜ inches. Two





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THE DE MATTIA

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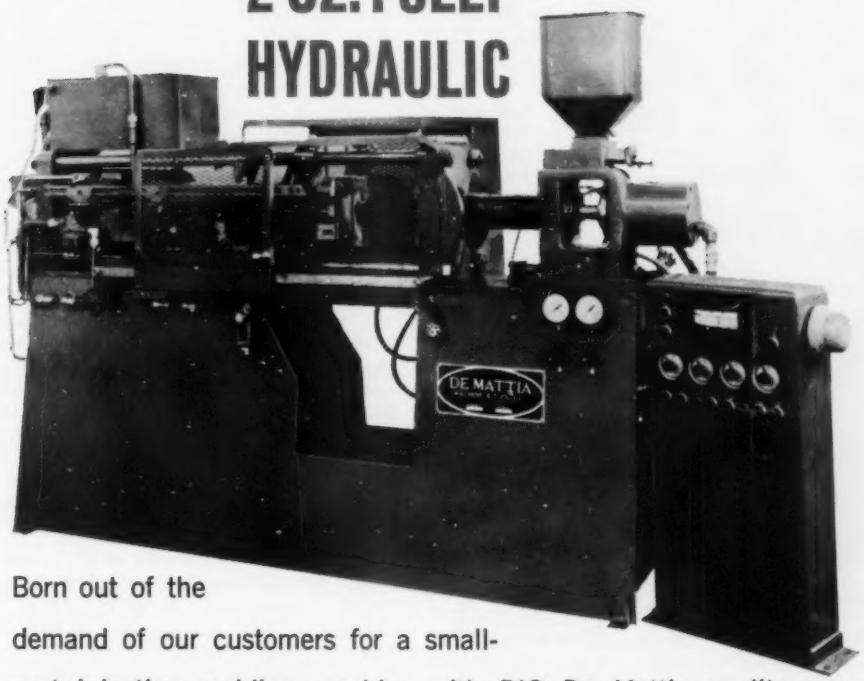


Born out of the demand of our customers for a small-part injection molding machine with BIG De Mattia quality, we proudly present the new De Mattia 2-ounce Model J. With the Model J, we offer the fastest fully hydraulic, fully automatic molding machine ever built—the only one of its kind in the world. Full vital statistics of this new arrival available on request.

DE MATTIA

DE MATTIA MACHINE & TOOL CO.• Main Office and Plant: CLIFTON, N. J.

Sales Representatives: ACME MACHINERY & MANUFACTURING CO., INC., 500 Saw Mill River Rd., YONKERS, N. Y.; 102 Grove Street, WORCESTER, MASS.

other new and smaller machines, having a shot capacity of about ¾ oz. and capable of handling molds up to 6 by 8½ in. are also available. One of these has a manual mold-closing arrangement; locking is hydraulic in both. *Dowding & Doll Ltd., 346 Kensington High St., London W14, England.*

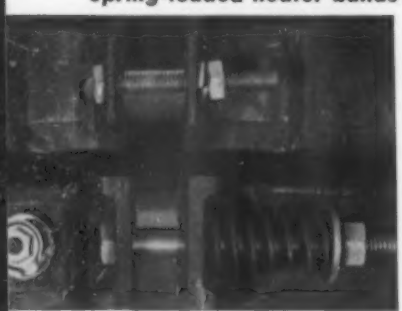
Extruder

Called the K-100 dual-purpose extruder, this unit was especially designed for the extrusion of polystyrene foam sheet. Standard equipment includes a 1-in. diameter screw with an L/D ratio of 20:1, a Xaloy-lined barrel, stainless steel feed section and hopper, a 1-hp. variable-speed drive, and gear reducer. Listed as optional equipment are water-cooled screws, air- or water-cooling in the barrel, pressure gage and swing gate. Special attention was paid to making the unit compact and suitable for heavy-duty production. *Killion Tool & Mfg. Co., 56 Depot St., Verona, N. J.*

Injection machine

This new Lester 12/16 oz. injection machine comes in two Models: the Standard L-400 and the High-Speed L-400B. Both will deliver up to 46.2 cu. in. of thermoplastic using a double feed stroke. High plasticating capacity combined with a long mold stroke facilitate the molding of deep-draw parts. Maximum injection pressure is 20,000 p.s.i.; plunger displacement speed is 12 cu. in./sec. on a 14-in. stroke. Complete injection stroke takes 4.8 sec. on the standard model and 3.2 sec. on the high-speed unit. Mold clamp force is 400 tons, while the mold opening is adjustable from 12 to 20 in.; total closing time with 12-in. opening is 3.6 sec. for the standard model and 2.4 sec. for high speed; with the 20-in. opening, 6.3 and 4.0 sec., respectively. *Lester-Phoenix Inc., 2711 Church Ave., Cleveland 13, Ohio.*

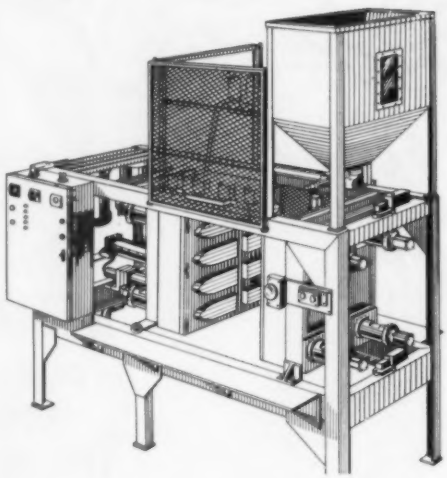
Spring-loaded heater bands



This line of modified Chromalox heater bands has been equipped with reinforced spring-loaded tightening flanges. Spring-loading of the tightening bolts on the heaters assures that the band makes a good contact with the heating cylinder in spite of expansion and contraction which loosens conventional bands and results in losses in efficiency and band life. Chromalox bands now in use on which the flanges have loosened or pulled off may be sent to the supplier for the installation of the spring-loaded clamping system, and thus reclaimed. *Injection Molders Supply Co. Inc., 17601 South Miles Rd., Cleveland 28, Ohio.*

Foam molder

The Model H-1 Cycle-Matic press (above, right) is designed for the molding of expandable polystyrene parts up to 28 in. square. It has an integral air/oil booster system which provides a clamp force of up to 12.5 tons and a maximum stroke of 24 inches. Clamping is horizontal. Once proper timers and switches have been adjusted, molding is completely automatic. Unit is supplied with built-in steam chests; only mold faces are needed for various applications. The feeding system can be adjusted to allow



two colors to run in the same mold. Also provided is a positive mechanical ejection system which lends itself to automatic take-off equipment. Typical cycle on parts having a ½-in.-thick wall and a foam density of 2 lb./cu. ft. is about 1 minute. *Springfield Cast Products Co. Inc., 124 Switzer Ave., Springfield 9, Mass.*

Granulator

This special-purpose unit, Model MB-150, has been designed specifically for reclaiming blow-molding scrap, such as large area rejects, bottles, and doll bodies, and injection-molding scrap, such as radio cabinets and large area toys. Special cutting arrangement includes two revolving and two stationary blades, including one blade with an extra amount of shear angle, and helps to prevent articles from bouncing out. Made of steel, the unit has a throat opening 10 by 12 inches. Capacity is 300 lb. per hour. The hinged hopper is designed for mounting and feeding from either side of the machine, and it may be easily tilted back for cleaning the cutters. On casters. *Ball & Jewell Inc., 24 Franklin St., Brooklyn 22, N. Y.*

. . . Machinery in brief

▸ Designed for high-speed machine tool applications, a complete line of rapid reversing motors are available in several constructions and offer up to 200 idle reversals per minute, depending on the design of the motor. *Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis.*

▸ A new variable-speed drive, the V-S Statatron, uses a static-rectified d.c. motor voltage source for wide range speed control of drive motors. Silicon diodes and saturable core reactors rectify the a.c. input. *Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.*

▸ A new U. S. Varidrive Explosion-proof motor, Type VA-EV, is now available in ratings of ¼-, ⅓-, ½-, ¾-, and 1-hp. Motor offers variable speeds in ratios up to 10:1 for applications in explosive atmospheres. *U. S. Electrical Motors Inc., P.O. Box 2058, Terminal Annex, Los Angeles 54, Calif.*

▸ The Model STI Mooney shearing disk viscometer is now available with a variable-speed drive which permits the study of plastics' viscosities at widely different rates of shear from 0.05 to 20 r.p.m. *Scott Testers Inc., 103 Blackstone St., Providence, R. I.*—**End**

Fred Vahlsing and the TR-101 shipping bag for packaged carrots he introduced . . . his most recent innovation in a long line of produce packaging "firsts".

Vahlsing adopts shipping bag of MARLEX* TR-101 for packaged carrots . . . top-icing used

Fred Vahlsing, president and founder of Fred H. Vahlsing, Incorporated, has been a leader in the development of produce packaging for nearly four decades. With carrots, he was the first with such innovations as cleaned and wrapped bunches (first with, then without green tops), wire-bound shipping crates, multi-wall paper shipping bags . . . and now, he has adopted tough, lightweight shipping bags made of MARLEX TR-101 high density plastic.

"These new plastic bags of TR-101", he relates, "cut our shipping costs because they permit the use of inexpensive top-icing. The multi-wall paper bag, that's standard today, requires more expensive refrigeration. TR-101 bags, on the other hand, have the strength and moisture resistance to withstand top-icing. The bags we use are only 3¼ mils thick. MARLEX TR-101 is an unbelievably strong plastic."

In addition to strength and moisture resistance, bags made from MARLEX TR-101 high density resin can withstand extremes of temperature (from hot storage at 140°F to cold storage below zero F) . . . and resist rot, fungi, and bacteria. Testing has also established that thinner-walled TR-101 bags outperform thicker-walled low density polyethylene bags . . . having up to 38% more tensile strength and 2½ times the impact strength.

For produce marketers and other bulk material packagers currently using paper, jute or low density polyethylene bags, metal or fiber drums, and the like . . . new TR-101 bag can mean more efficient packaging. They offer excellent protection against product loss from handling or moisture spoilage . . . attractive packaging with colored or translucent film . . . and reduced freight costs. TR-101 film is also easy to seal with automatic or hand sealing equipment now available.

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PHILLIPS 66 MARLEX PLASTICS

WORLD-WIDE PLASTICS DIGEST*

Abstracts from the world's literature relative to plastics. For complete articles, send requests direct to publishers. List of addresses is at end of this section.

General

Cellulose: Old partner yields new product. Chem. Week *88*, 35-36 (Apr. 22, 1961). The grafting of groups onto cellulose produces new polymers. Types and possibilities are reviewed.

Pushing for novel nylons. Chem. Week *88*, 91-2, 94 (Apr. 15, 1961). Twelve old and new polyamides, both plastic and fiber types, are discussed. These include nylon 6/6, 6/10, 6, 11, 4, 7 (two types), 8, and 9, polyoxamides, and two nylons with aromatic rings.

Materials

Moldable ceramoplastic for 1200° F. service is vacuum-tight. Materials in Design Eng. *53*, 14-15 (March 1961). A ceramoplastic dielectric that can operate continuously at temperatures as high as 1200° F. and that can be molded into many precise, complex parts is described.

Properties of high-modulus reinforced plastics. G. P. Peterson. SPE J. *17*, 57-62 (Jan. 1961). Glass fiber containing beryllium oxide was evaluated as a reinforcing material in laminates. The glass fiber shows definite advantages over "E" glass when an increased modulus of elasticity is of primary importance. However, the strength properties of the laminates are greatly dependent on the fiber finish and resin used. Best results have been obtained with the high-modulus glass using A-1100 fiber finish and an epoxy resin hardened with m-phenylenediamine.

Molding and fabricating

Matched metal molds for reinforced plastics. E. G. Donaldson. Plastics *26*, 137-38 (Jan. 1961). Matched metal dies made from high duty iron of the Meehanite type are described. The production of the dies, types of surface finish available, methods of producing mold cropping edges, corrosion resistance, and cost are discussed.

Welding of Teflon and other polymeric materials by the localized action of neutron radiation. I. M. Barkalov, V. I. Goldanskii, B. G. Dzantiev, and E. V. Egorov. Vysokomolekuliarnye Soedineniia *2*, 1801-04 (Dec. 1960). The welding of materials by irradiation with neutrons can be effected by ionizing radiation with the aid of boron and lithium compounds applied to the surfaces subjected to the welding process. The radiation welding of the following pairs of polymers has been done successfully: Teflon–polystyrene, Teflon–polymethyl methacrylate, polystyrene- polymethyl methacrylate, polyethylene-polystyrene, and polyethylene–polymethyl methacrylate. The tensile strength of the bonded Teflon–polystyrene pair attains a value of 120 kg./cm.^{2} (1700 p.s.i.). Possible mechanisms of the welding reaction are discussed and some quantitative evaluations are presented. Three-layer welding of PE and Teflon was achieved by using as an intermediate layer polystyrene film which contained either lithium or boron compounds.

*Reg. U.S. Pat. Off.

Applications

Synthetics in paper coating. E. D. Curphey. Plastics *26*, 113-14 (Jan. 1961). Styrene-butadiene and styrene-maleic acid copolymers are important coating materials for paper and have largely replaced more traditional materials such as starch, casein, and gum tragacanth. Methods of coating with the synthetics and examples of the type of application for which they are suited are described.

Properties

Specific heat for thermosetting polymers. R. W. Warfield, M. C. Petree, and P. Donovan. J. Applied Chem. *10*, 429-32 (Oct. 1960). The specific heats of a number of amorphous thermosetting polymers were determined by means of an adiabatic calorimeter. Epoxy, polyester, polyamide-epoxy, and diallyl phthalate polymers frequently exhibit abrupt increases in the observed specific heats due to a glassy transition within the polymer. The results that were obtained are correlated with the structure of the polymers.

Steric order and dielectric behavior in polymethyl methacrylates. H. A. Pohl, R. Bacskai, and W. P. Purcell. J. Phys. Chem. *64*, 1701-05 (Nov. 1960). Steric order in polymethyl methacrylate affects the molar polarization, X-ray diffraction, and infra-red spectra. The isotactic material has the highest molar polarization and the shortest mean relaxation time in solution. The fewest infra-red absorption peaks and the greatest ease of crystallization were observed with the bulk isotactic material. The most infra-red absorption peaks and intermediate ease of crystallizability were observed with the bulk syndiotactic material. There are 18 most probable conformations of stereospecific polymethyl methacrylate.

Testing

Measurement of polyethylene oxidation by differential thermal analysis. A. Rudin, H. P. Schreiber, and M. H. Waldman. Ind. Eng. Chem. *53*, 137-40 (Feb. 1961). A differential thermal method for measuring the degree of oxidation of polyethylene is described. Its results agree satisfactorily with those of other methods at comparable temperatures, and its advantage lies in its fast, convenient operation at temperatures used in polyethylene processing. The method should be useful for studying oxidation resistance of plastics and rubbers under conditions of industrial interest.

Water vapor transmission testing. Materials Research & Standards *1* (Formerly *ASTM Bulletin*), 117-121 (Feb. 1961). The results of four round-robin testing programs in nine different laboratories on water vapor transmission through various materials are presented. Tests were in accordance with ASTM Tentative Methods of Test for Water Vapor Transmission for Materials Used in Building Construction (C 355). Results for both the water and desiccant methods are reported. Testing temperature ranged from 70 to 90° F. A standard water vapor transmission specimen would enable any laboratory to check its measurements. A polyester (Mylar) film offers promise for this purpose.

Publishers' addresses

Chemical Week: McGraw-Hill Publishing Co. Inc., 330 W. 42nd St., New York 36, N. Y.

Industrial and Engineering Chemistry: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

Journal of Applied Chemistry: Society of Chemical Society, 56 Victoria St., London SW1, England.

Journal of Physical Chemistry: American Chemical Society, 1156 Sixteenth St., N. W., Washington 6, D. C.

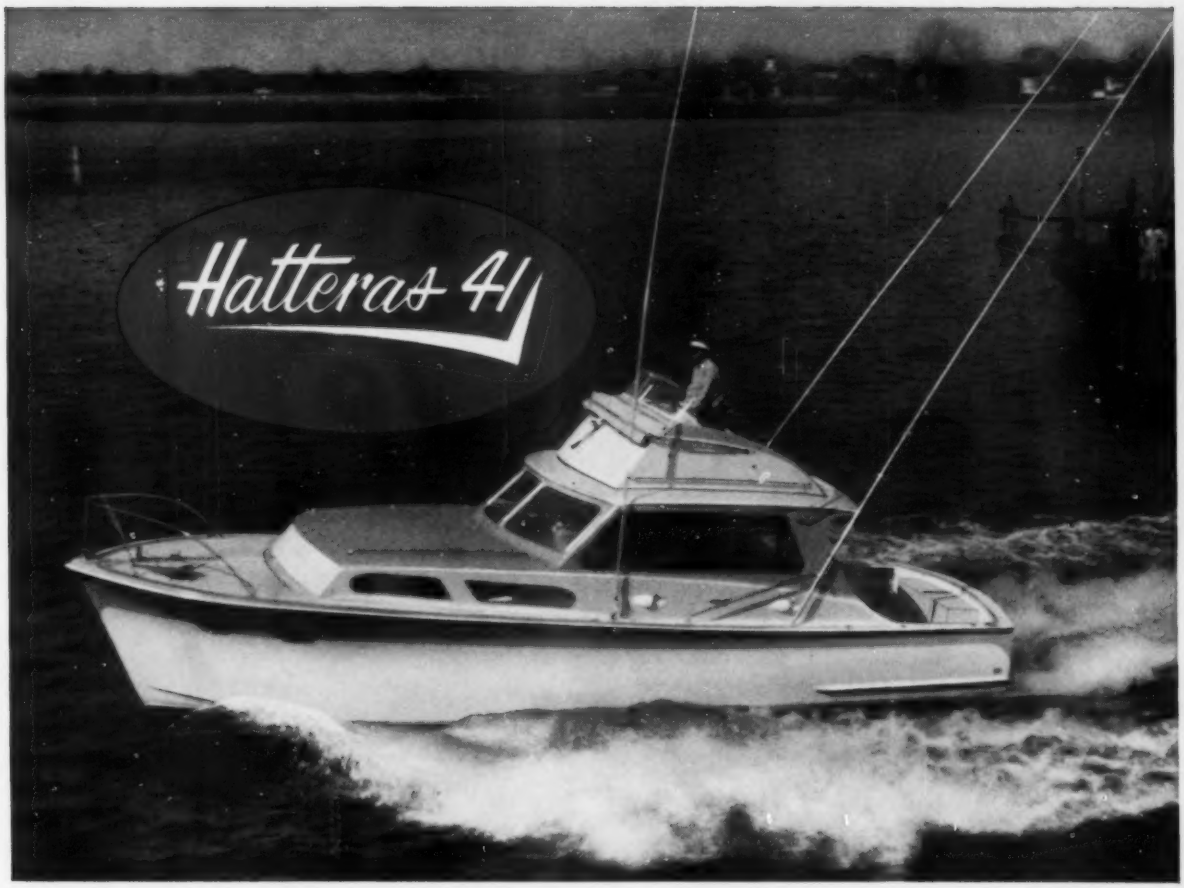
Materials in Design Engineering: Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

Materials Research and Standards: American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Plastics (London): Temple Press Ltd., Bowling Greene Lane, London EC1, England.

SPE Journal: Society of Plastics Engineers Inc., 65 Prospect St., Stamford, Conn.

Vysokomolekuliarnye Soedinenila: Academy of Science of U.S.S.R., Moscow, Russia.—End



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U.S. PLASTICS PATENTS

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.

U.S. Pats., Feb. 21, 1961

Methyl methacrylate molding. L. Birckhead Jr. and T. A. Birckhead (to Birckhead). 2,972,170.

Vinylpyridine polymers. T. M. Laakso, J. L. R. Williams, and C. S. Garber (to Eastman Kodak). 2,972,535-6-7-8.

Photopolymerizable compositions. W. R. Saner and M. Burg (to Du Pont). 2,972,540.

Foamed resin pad. I. E. Muskat and J. J. Klein (to Fiber Bond). 2,972,-554.

Perm-selective polyvinylchloride. J. H. van der Neut, H. G. Roebersen, A. Schors, and O. P. van der Werff (to Toegepast-Natuurwetenschappelijk). 2,972,586.

Epoxy resin composition. J. Cunder and F. J. Licata (to Nopco). 2,972,590.

Butadiene-furfural-maleic composition. M. T. Harvey and P. L. Rosamilia (to Harvel). 2,972,591.

Dialkyl tin epoxy-succinate stabilizers. A. Bavley and C. J. Knuth (to Chas. Pfizer). 2,972,595.

Unsaturated acetal-trisphenol resins. H. R. Guest and J. T. Adams (to Union Carbide). 2,972,599.

Acrolein-pentaerythritol resins. H. R. Guest, B. W. Kitt, and C. B. Halstead (to Union Carbide). 2,972,601.

Pyridine-ring containing resins. F. E. Cislak (to Reilly Tar). 2,972,603.

Chlorosulfonation of polyethylene. W. B. Reynolds and P. J. Canterino (to Phillips). 2,972,604.

Hydroperoxides of high polymers. G. Natta, E. Beati, and F. Severini (to Montecatini). 2,972,605.

Aminoethylation of cellulose. R. J. Hartman and E. J. Fujiwara (to Wyandotte). 2,972,606.

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Plastic mixer. D. W. MacLeod (to Farrel-Birmingham). 2,972,774.

Forming sheet material. R. P. Baillie and W. H. Smith (to Demmler and Schenck). 2,972,775.

Extrusion. B. B. Boonstra (to Cabot). 2,972,780.

Cartridge case coated with polytetrafluoroethylene. V. G. Fitzsimmons and W. A. Zisman (to U. S.). 2,972,947.

Self-bonding material. P. J. Canterino (to Phillips Petroleum). 2,973,088.

Plastic car body. A. M. White. 2,973,220.

Olefin polymers. J. N. Scott Jr. and R. V. Jones (to Phillips) 2,973,241.

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Unsaturated polyesters. H. Fikentscher, H. Wilhelm, and H. Willersinn (to Badische Anilin). 2,973,332.

Polyurethane. M. Katz and E. L. Wittbecker (to Du Pont). 2,973,333.

Polysiloxane-carbodiimide resin. J. Jack (to Imperial Chemical). 2,973,334.

Polystyrene - naphthalene - formaldehyde. H. A. Gottschall. 2,973,338.

Terephthalate polyesters. W. Muenster and E. Dreher (to Bayer). 2,973,339.

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U.S. Pats., Mar. 7, 1961

Polyester composition. A. K. Forsythe and J. A. Parker (to Armstrong Cork). 2,974,112.

Polyvinyl acetate-isobutyl ether. R. Steckler and F. J. Prescott (to General Aniline). 2,974,114.

Polyacrylonitrile. S. A. Heininger and P. R. Graham (to Monsanto). 2,974,115.

Polyesters. J. A. Parker, H. R. Ready, and J. Versnel (to Armstrong Cork). 2,974,116.

Vinylidene polymers. G. Nischk (to Bayer). 2,974,118.

Polyacrylonitrile. W. H. Schuller and D. C. Guth (to American Cyanamid). 2,974,119.

Linear polyester. J. Lincoln, B. J. Hawthorne, and E. J. Kowolik (to British Celanese). 2,974,122.

Polyacrylonitrile. C. C. Ketterer (to Du Pont). 2,974,123.

Biurea-carboxylic acid resin. C. S. Grove Jr., G. F. Grillot, and V. T. Stannett (to W. R. Grace). 2,974,124.

Methacrylate copolymers. J. L. Lang, C. Jones, A. F. Roche, and F. L. Ingley (to Dow). 2,974,125.

Unsaturated acetal resins. D. E. Hudgin (to Celanese). 2,974,127-8.

Olefin polymers. N. F. McLeod (to Phillips). 2,974,131.

Polyethylene. B. Jacobi (to Hüls). 2,974,132.

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Rope of polypropylene. E. Coggi (to Montecatini). 2,974,559.

Pulverizing plastics. T. Engel (to Vasco). 2,974,883.

Shrinkproofing textiles. T. J. Coe (to U. S.). 2,975,077.

Nylon-Teflon composite. L. S. Stott (to Polymer). 2,975,128.

Cellular polyurethane. T. H. Rogers Jr. and D. W. Peabody (to Goodyear). 2,975,146.

Polyester composition. C. W. Abbott and H. I. Freeman (to Sherwin-Williams). 2,975,147.

Epoxy resin. R. A. Skiff (to General Electric). 2,975,148.

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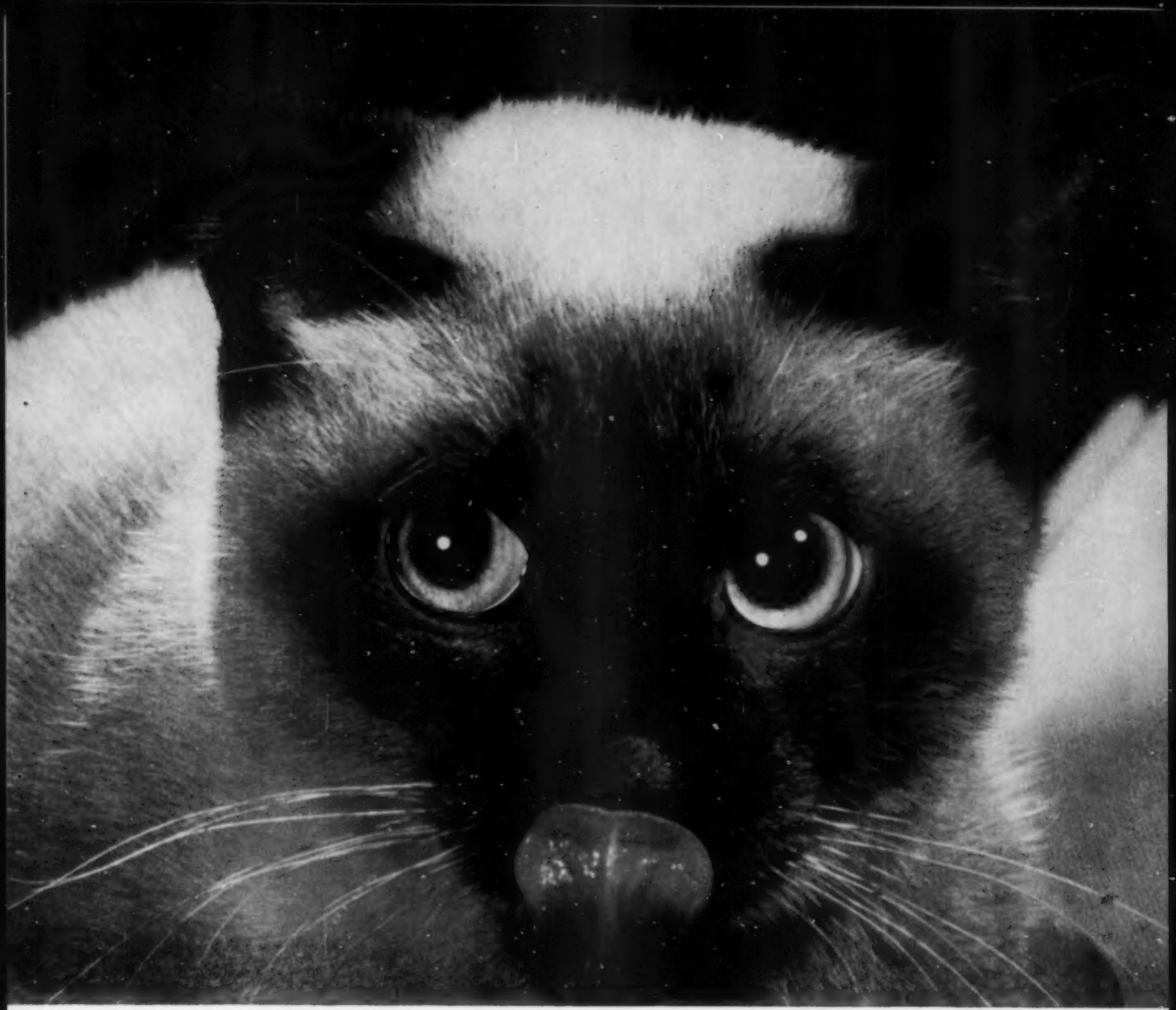
Vinyl plasticizers. M. J. Hurwitz, A. M. Craig Jr., and E. M. Beavers (to Rohm & Haas). 2,975,152.

Piperazine-diisocyanates. M. Katz (to Du Pont). 2,975,157.—**End**



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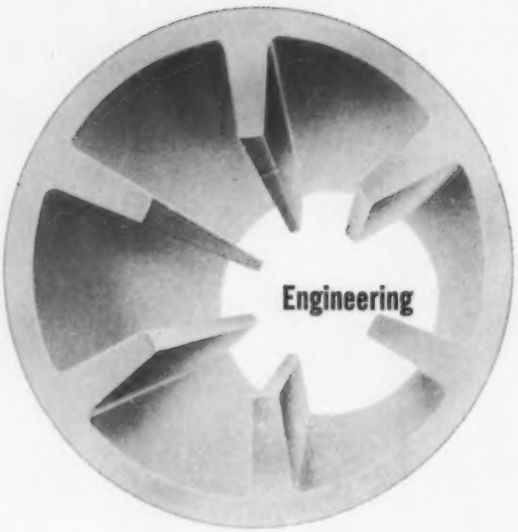

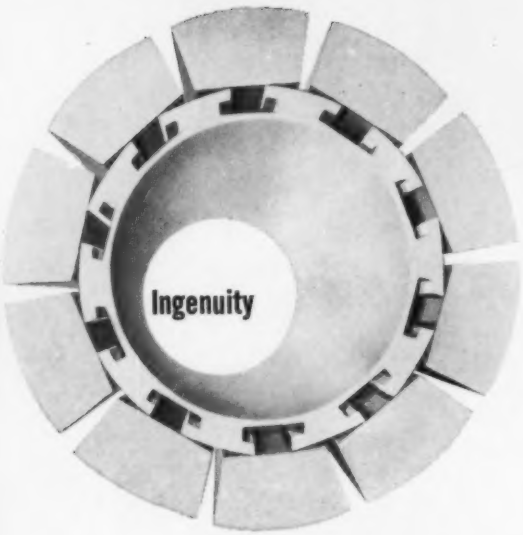

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Cyanamid additives for plastics can mean longer life, better wear, less discoloration, minimal brittleness. Or they can mean static-free products—no accumulating dust or lint. Today—they are stimulating growth of new uses and markets for plastics. • Cyanamid additives will surely bring new sales advantages to your products, greater satisfaction to your customers, more profits for you. If you'd like to see how Cyanamid research and experience can help you—a letter or phone call to us will start things moving. No obligation. Contact Cyanamid today! • American Cyanamid Company / Intermediates Dept. / Bound Brook, N.J.

Among Cyanamid's additives for the plastics industry: • *Cyasorb®* *Light Absorbers:* Screen out damaging ultra-violet light in vinyls, lacquers and varnishes, reinforced polyesters, laminated safety glass, and other materials. • *Antioxidants:* Minimizes brittleness, discoloration, cracking, in end uses. • *Antistatics:* Greatly reduce static electricity accumulation and keep finished products lint-free, dust-free, more saleable.

CYANAMID

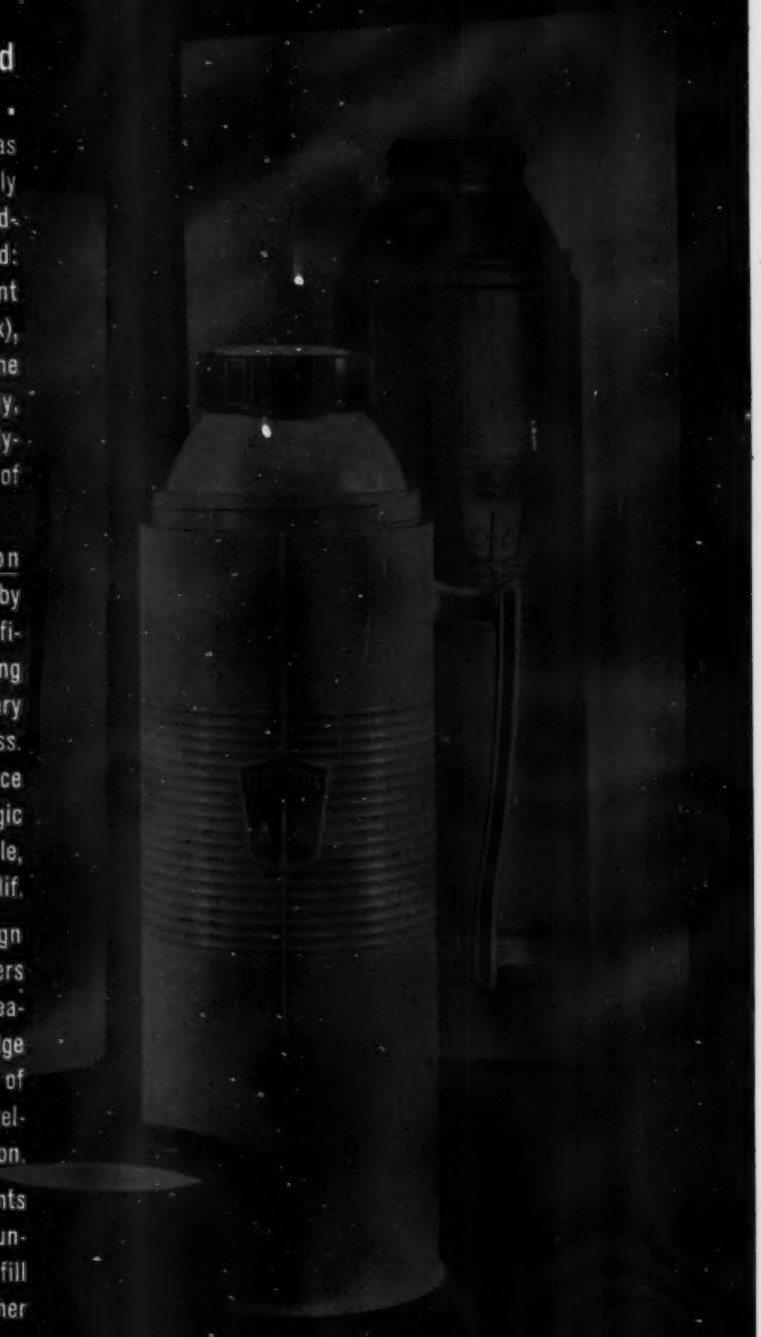
From Plastene—a world of precision plastics...

For 15 years, Plastene Corporation has been supplying customers in virtually every field with molded plastic products fabricated to a single standard: Plastene Precision. Such prominent firms as The U.S. Time Corp. (Timex), Fram Corp., Sears Roebuck & Co., The American Thermos Products Company, Amity Leather Products Co. and Lily-Tulip Cup Corp. are consistent users of Plastene's products and abilities.

What does Plastene Precision mean? It means molds designed by Plastene and built to its rigid specifications. It means precise engineering and skilled fabrication through every step of the manufacturing process. And it means prompt, efficient service from plants located in three strategic geographical areas — Crawfordsville, Ind., Norwich, Conn. and Anaheim, Calif.

Plastene is equally noted for design leadership. Its prominent designers are recognized for originality and creativity and for their intimate knowledge of the characteristics and scope of polystyrene, polyethylene, acrylic, delrin, polypropylene, acetate and nylon.

Whether your plastic requirements are simple or complex, Plastene's unsurpassed facilities and skills can fill them. Why not write today for further information?



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Plastene Corporation, Crawfordsville, Indiana • Subsidiary of The American Thermos Products Company

Speed... Precision... Versatility

DAKE

Reinforced Plastic Molding Presses

GUIDED PLATEN—Assures accurate alignment.

AUTOMATIC, SEMI-AUTOMATIC, OR MANUAL CONTROL—For production or experimental work.

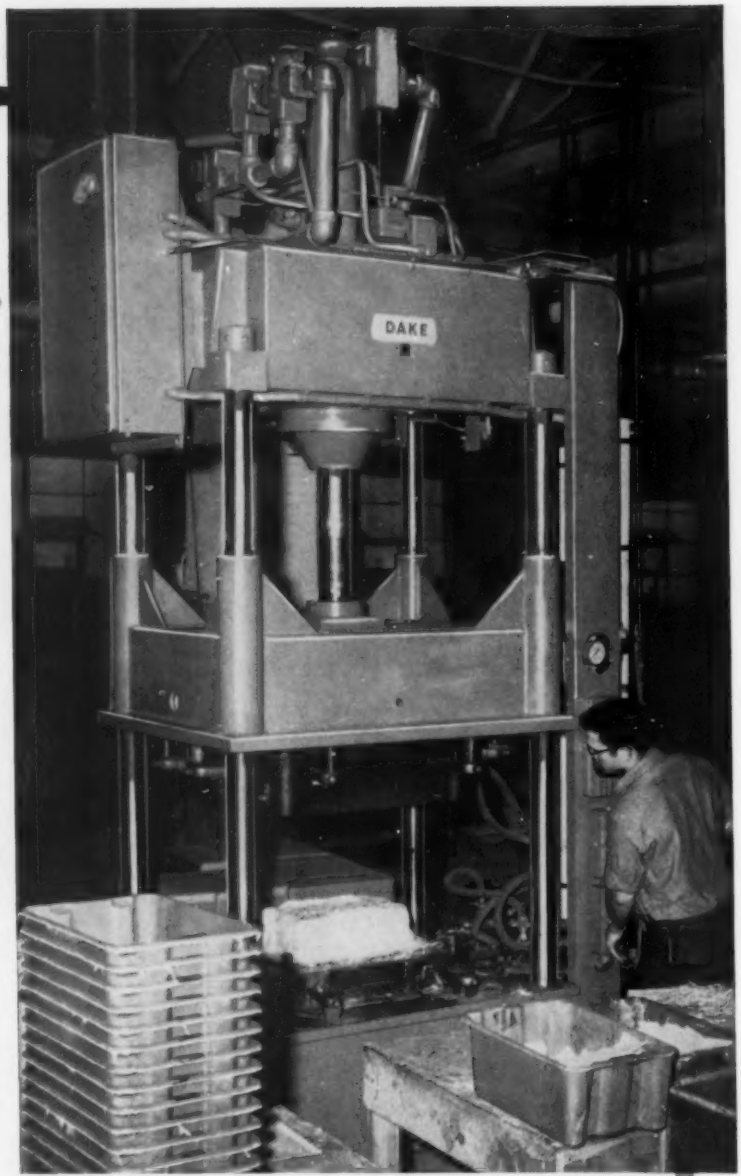
FAST RAM APPROACH—Allows for fast closing and return of movable platen. Slows automatically as work is approached.

ACCURATE, CONTROLLED PRESSURES—Give maximum on-the-job flexibility.

ELECTRIC TIMER—Holds pressure during curing cycle—adjustable from 3 seconds to 20 minutes. Ram returns automatically.

ADJUSTABLE STROKE CONTROL—Provides for automatic ram slowdown before contacting work.

ADJUSTABLE PRESSURE—From ⅓ press capacity to full press capacity.



75-Ton Dake Guided Platen Plastic Molding Press forming Stack-n-Nest tote pans at G. B. Lewis Company, Watertown, Wisconsin.

Dake Guided Platen Presses are the latest development in the reinforced plastic molding field. They are job engineered to help you meet all molding requirements, as well as speed production output, and reduce operating costs. Their all-steel construction with long tie rod bearings and larger diameter tie rods provide maximum rigidity to assure extremely accurate work with all types of plastic forms. Standard models are electric-hydraulic in operation and available in capacities from 25 tons to 600 tons. Write for Bulletin 405.

DAKE PRESSES

DAKE CORPORATION
648 Robbins Road
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LONG TERM HEAT AGING STABILITY

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Yours with new Escon® 125 molding grade polypropylene!

Household appliances, radio cabinets and TV backings take full advantage of the remarkable properties of Escon 125 polypropylene. This outstanding new grade is designed to maximize performance for long periods at high temperatures. Exceptional performance is achieved through a special LTHA (Long Term Heat Aging) stabilization system developed by Enjay research affiliates.

Escon 125 offers oxidative stability that, in carefully conducted laboratory tests against other commercially available grades of polypropylene designed for this type of service, outperformed all others tested. Specimens of Escon 125 withstood almost three months of oxidative aging at 300°F; specimens exposed to 250°F have shown no signs of failure after seven months.

Melt index is 5.5 at 230°C. No changes are required in equipment, processing conditions or coloring techniques from those used with general purpose molding grades. For test samples and typical properties of new Escon 125, write to Enjay, 15 West 51st Street, New York 19, New York.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY PLASTICS

8 square-foot Controlens being removed from the machine. Thickness of the molded piece is .100", and the weight is 7.1 pounds.

FARREL WATSON-STILLMAN ALSO MANUFACTURES

Horizontal injection molding machines in capacities from 5 to 500 ounces • vertical injection molding machines in 1, 2, 6, 16 and 22-ounce sizes • compression and transfer molding machines with clamping capacities ranging from 50 to 1200 tons • laboratory presses in 30, 50 and 100-ton sizes • general purpose presses in 30, 50, 100 and 200-ton capacities.

At Holophane they find that...

acrylic lenses of 8 square feet can be molded with great precision on a P-300-1750

"We are very impressed with the operation to date of our new Farrel Watson-Stillman, 300-ounce machine," reports R. V. Smith, manager Prismalume Division, Holophane Company, Inc. "We expected to be able to mold acrylic sections of 8 square feet projected area and this was done successfully. But we were pleased and surprised by the speed and reliability which have both been excellent."

A pioneer in the field of controlled illumination, Holophane produces acrylic plastic lenses of thin cross section, incorporating a fine prismatic pattern. Because of the accuracy required in the molding of the critical prismatic angle, only injection molding under high pressure will deliver a satisfactory result. And, of course, where high molding quality is vital, particularly in a product of great area, a Farrel Watson-Stillman machine is a logical choice.

In addition to the 300-ounce machine, Holophane has several Farrel Watson-Stillman machines ranging from 175 to 200 ounce capacity each. These are used in molding plastic lenses of diverse size and design, and help Holophane maintain a reputation for quality molding while contributing production speed and reliability.

For your own molding operation, it will pay you to learn more about *the world's broadest line of machinery for molding plastics.* Send for a free copy of bulletin 600, which gives specifications for all the different sizes and types available.

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WATSON-STILLMAN PRESS DIVISION
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FARREL WATSON STILLMAN ®

View of the Holophane plant in Union, New Jersey, showing the new 300-ounce machine in action.

WS-81

Why you can count on top quality in Sylvania Metallizing Coils

The pile in the foreground of the photo above is wolframite ore.

First, Sylvania knows the materials. Our experience in manufacturing billions of metallizing coils is your assurance of top performance.

Second, in making these coils, Sylvania *starts* right with the ore and maintains maximum quality control from refining straight through the finishing process.

Third, our plant flexibility is such that you can name the design and Sylvania can produce the coil. In standard designs you can even name the quantity and, chances are, Sylvania can supply your needs *right off the shelf*.

Result: you get highest quality coils at volume prices—and you can be sure of efficient, uniform metallizing.

For further information—and outstanding technical help with your vacuum-metallized problems—write Chemical & Metallurgical Division, Sylvania Electric Products Inc., Towanda, Pennsylvania.

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Reg. U. S. Pat. Off.

PLASTIC INJECTION MOLDING MACHINES

one will do your molding

(sub-miniature to 2 Oz.)

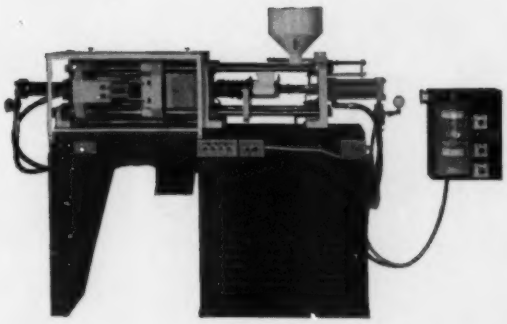
better . . . for less.

Whatever your plastic injection molding problem, from sub-miniature to 2 oz., a MINI-JECTOR plastic injection molding machine will fit your precise needs.

They're the ideal answer to profitable, precise molding whether it's fast, steady, low-cost production or laboratory experimentation.

MINI-JECTORS mold all thermoplastics, including nylon, quicker, better, for less.

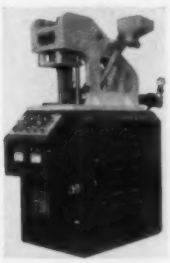
MINI-JECTORS cost less . . . models start under $1,000 . . . Mold blanks as low as $29.50.



IMPERIAL MINI-JECTOR

Fully automatic. Up to 2 oz. capacity. Hydraulic. Approximately 42 tons clamping pressure. 9″ x 12″ mold area. Up to 10 cycles per minute. Interchangeable cylinders. Horizontal clamping 2-zone heating cylinder. Prepack stroke—$6,380.

ELDORADO MINI-JECTORS



Semi-automatic and Manual. Up to 1½ oz. capacity. Mold area 6″ x 5⅛″ x 5″. Hydraulic power. Ideal for molding involving inserts or loose cores. $4,975. and $3,385.

HORNET MINI-JECTORS

Fully automatic, semi-automatic, manual. Horizontal clamping. Capacity to 1 oz. Air or hydraulic. From $1,785. to $3,600.

WASP MINI-JECTORS

Manual operation. Up to ¾ oz. capacity. Air or hydraulic. Uses inexpensive, self-locking "V" molds. Ideal for molding involving inserts or loose cores. From $965. to $2,368.

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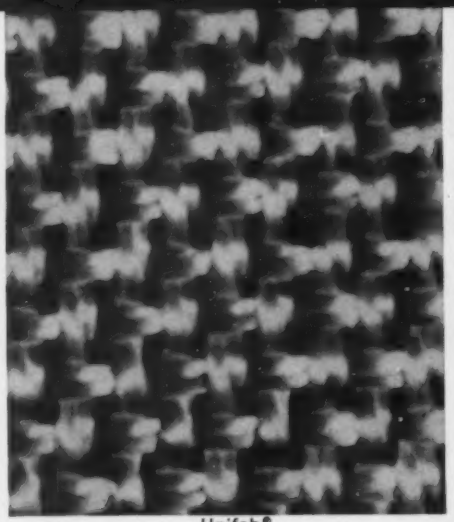

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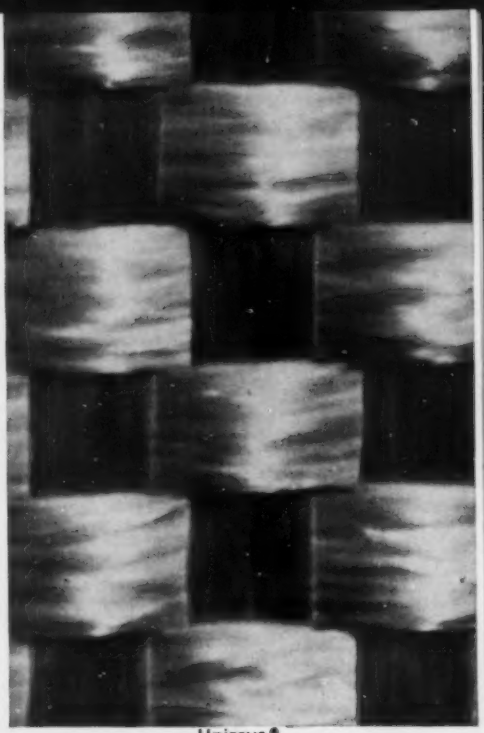

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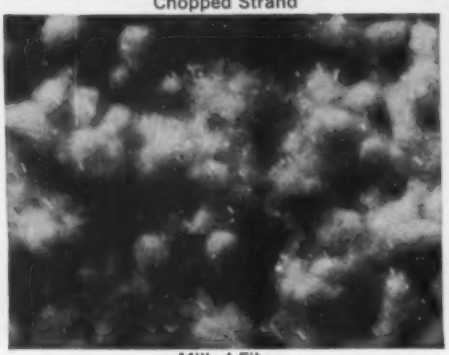

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Here is the first truckload of Lexan® Polycarbonate Resin leaving General Electric's plant at Mt. Vernon, Indiana. Dr. George E. McCullough (right), Plant Manager, receives the shipping papers.

The Correct Material

Correct Die Design & Production

This shipment is received at Quinn-Berry Corporation, Erie, Pa. by James P. Quinn, L. L. Berry, A. P. Wagner and James P. Murphy (left to right).

The Result

Molded Lexan® Card Guides for IBM 1401 processing unit ejecting from mold in Quinn-Berry Plant.

at *Quinn-Berry* The Result Is Our Most Important Product

The Requirement:

To produce Card Guides molded to close tolerances for IBM processing unit 1401, excellent dimensional stability must be maintained over a wide range of service conditions.

General Electric's Lexan® polycarbonate resin was chosen to meet the desired requirements.

Skillful mold design and expert craftsmanship in the press room teamed up at Quinn-Berry to meet accurately these rigorous demands.

The Result:

Quinn-Berry molded IBM Card Guides help maintain card position during card processing, hold required dimensional stability regardless of thermal changes, have extreme resistance to impact and are self-extinguishing.

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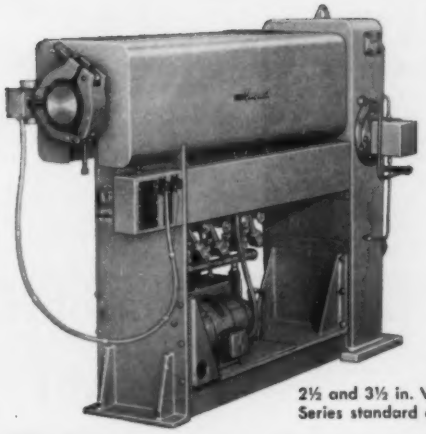
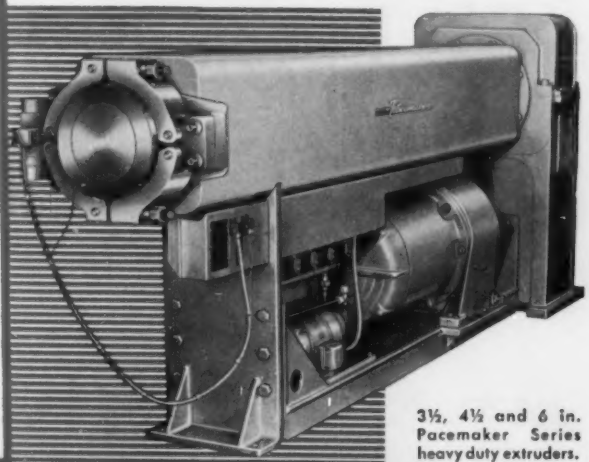
In fact, NRM builds complete package units for production of flat or corrugated sheet, plastic pipe, flat or blown film, monofilament, pellets, and for wire coating.

Extruder-dryers . . . custom extruders for special applications . . . dies . . . haul-offs . . . tanks . . . vacuum hoppers . . . related accessories — NRM offers them all.

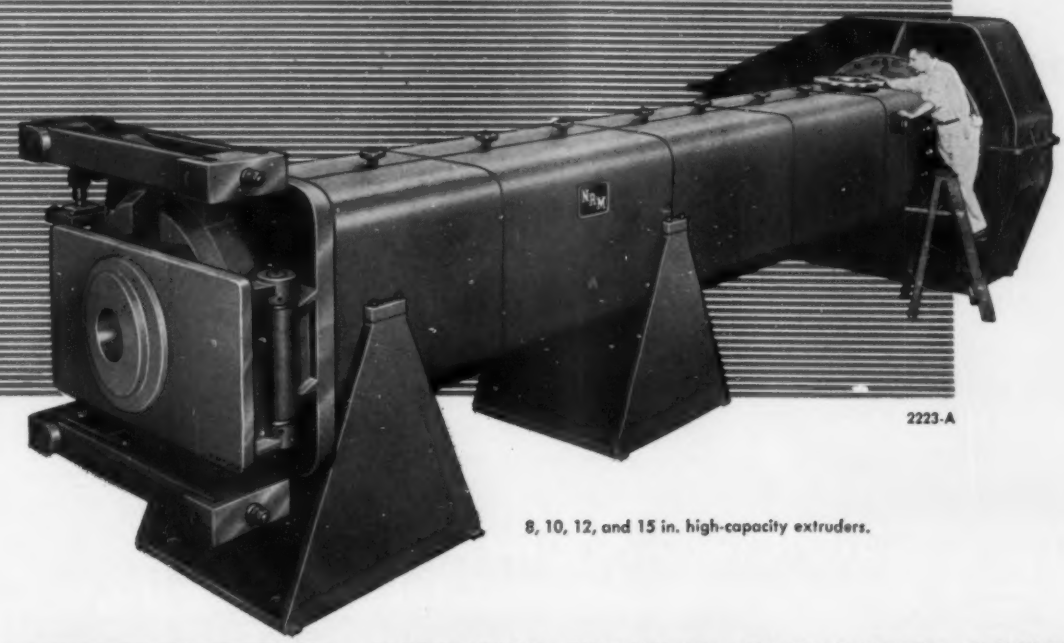
And, NRM'S years of experience in the development and manufacture of the finest plastics production machinery available today are at your service. Whether you're concerned with productivity, product quality, cost reduction, or a new process, you'll be money ahead if you call in NRM for recommendations while your project is in the planning stage. Call, wire or write today.



2½ and 3½ in. Vanguard Series standard extruders.



3½, 4½ and 6 in. Pacemaker Series heavy duty extruders.



2223-A

8, 10, 12, and 15 in. high-capacity extruders.

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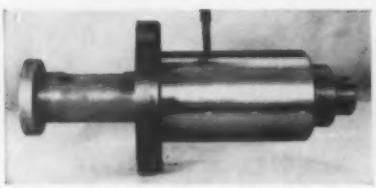
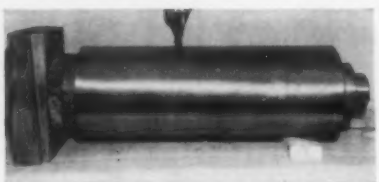
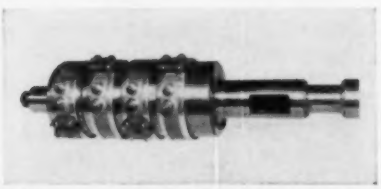


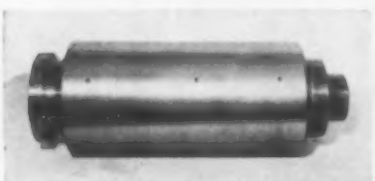
8oz.FELLOWS....$2150.00



20-24oz.WATSON.$4700.00

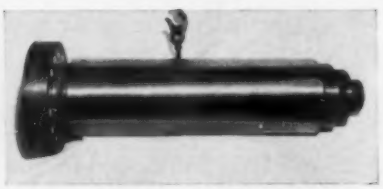


2½oz.VAN DORN.$1155.00

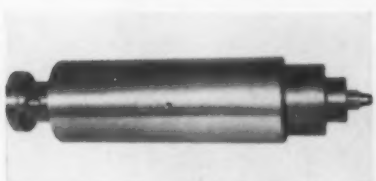


12oz.IMPCO.....$2750.00

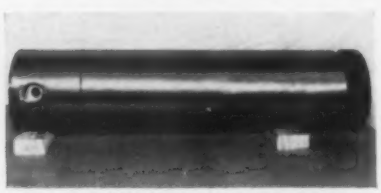
4oz.MOSLO.....$1325.00



18oz.LOMBARD....$3850.00

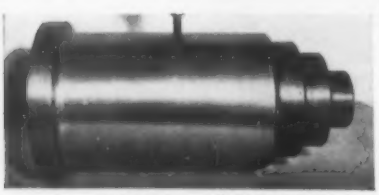


6oz.LEWIS....$2150.00



12oz.LESTER..BVRF $2950.00

3oz.STOKES..VRF $1495.00



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- Increased capacity
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- Increased mold area
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- Fewer rejects

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Check Plastolein Polymeric performance on eight important properties against two leading competitors →

4 NEW POLYMERICS join famous Plastolein® 9720

now the most complete line of low cost polymeric plasticizers in the industry

Emery research has achieved a significant breakthrough in the field of polymeric plasticizers. Four new polymerics have been introduced to complement Plastolein 9720, the industry's largest selling polymeric. Together, they now give you a single source for a wide range of your plasticizer needs. Although Plastolein 9720 will continue to be the choice in uses demanding its ease of processing and low viscosity, the four new plasticizers meet other needs:

Plastolein 9722: An improved version of Plastolein 9720 in humidity and outdoor aging, compatability, extraction and migration—at the same low cost. (Formerly Emery 3282-D)

Plastolein 9730: Now, the lowest cost polymeric plasticizer featuring low migration properties, excellent outdoor stability, and good soapy water resistance. (Formerly Emery 3311-D)

Plastolein 9750: A good, general-purpose, medium molecular weight polymeric at low cost, with excellent soapy water extraction and outdoor stability. (Formerly Emery 3313-D)

Plastolein 9765: The medium molecular weight polymeric plasticizer offering the best all-around permanence. Its cost is low, humidity aging outstanding, and extraction resistance tops. Special deodorized grade available. (Formerly Emery 3314-D)

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	Plastolein 9720	Plastolein 9722	Plastolein 9730	Plastolein 9750	Plastolein 9765
Coated upholstery fabrics	■	■	■	■	■
Unsupported films	■	■	■	■	■
Baby wear	■	■	■	■	■
Wall coverings	■	■	■	■	■
Vinyl-metal laminates	■	■	■	■	■
Shoe constructions	■	■	■	■	■
Surgical tapes				■	■
Industrial tapes		■	■	■	■
Plastisols, organosols	■	■	■	■	■
Coated paper	■	■	■	■	■
Pigment grinding	■	■		■	■
Refrigerator gaskets					■
Flooring	■	■	■	■	■
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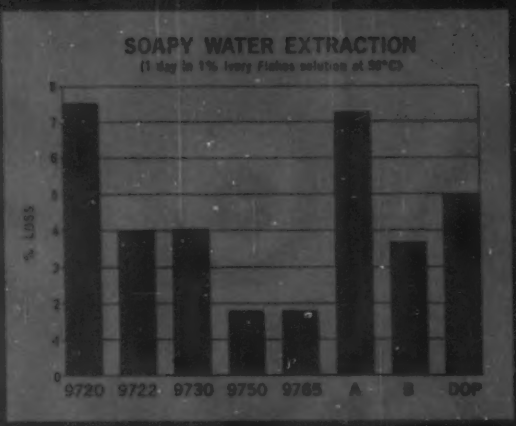
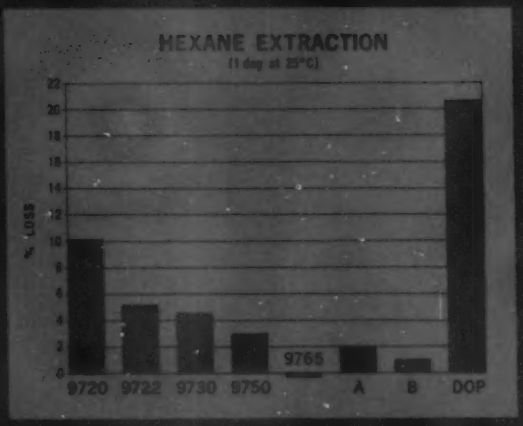
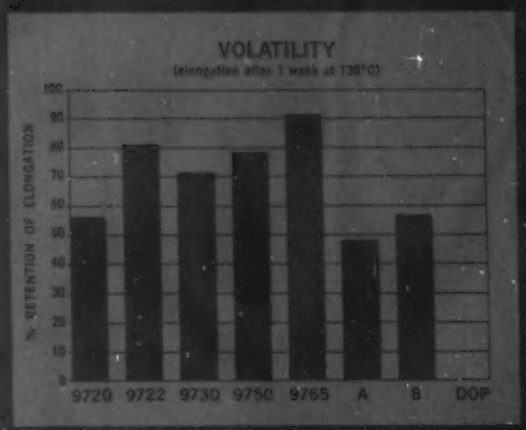
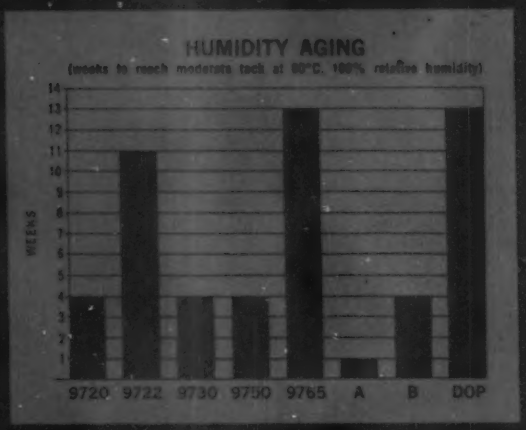
Emery

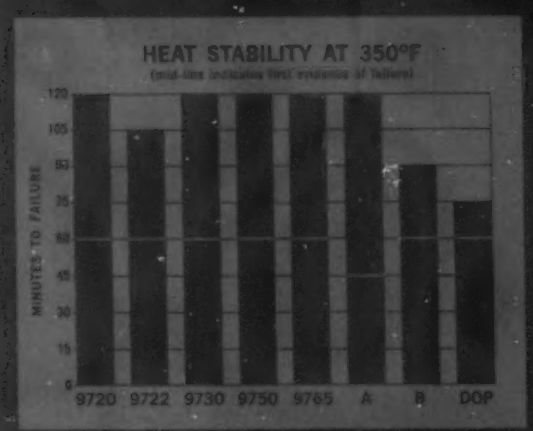
Polymeric Performance At Efficiency Concentration (Modulus = 1300 = 100)

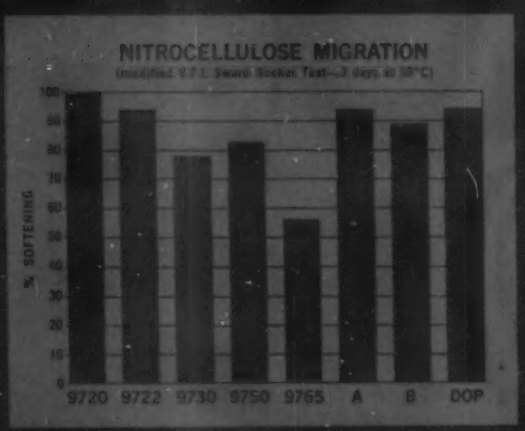


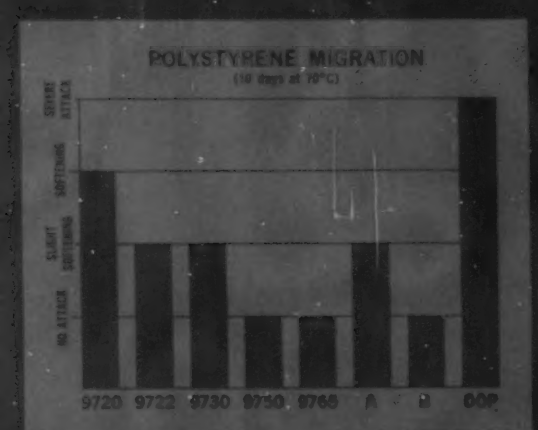


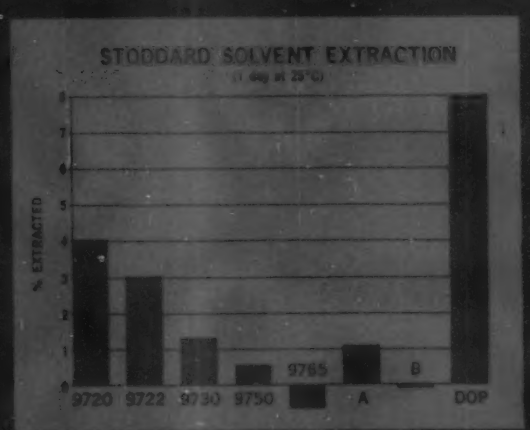








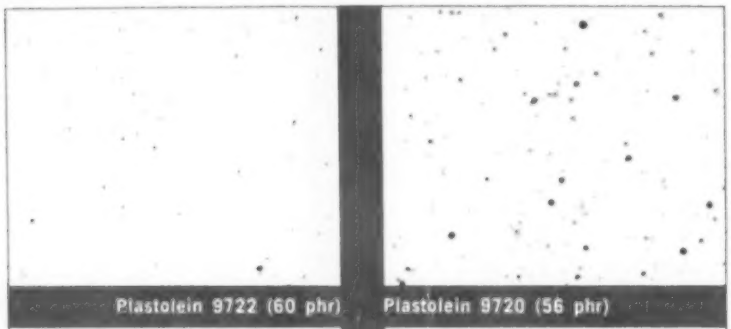




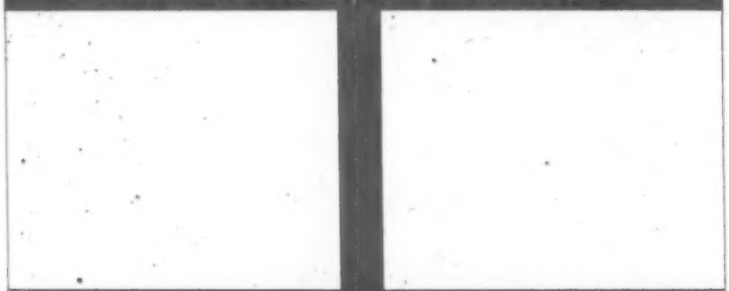
See Florida aging results on the back of this folder

COMPARE

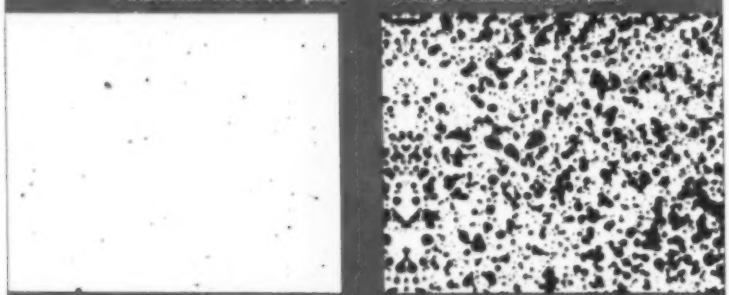
new Plastolein Polymerics with two leading competitors after 600 hours of Florida sun



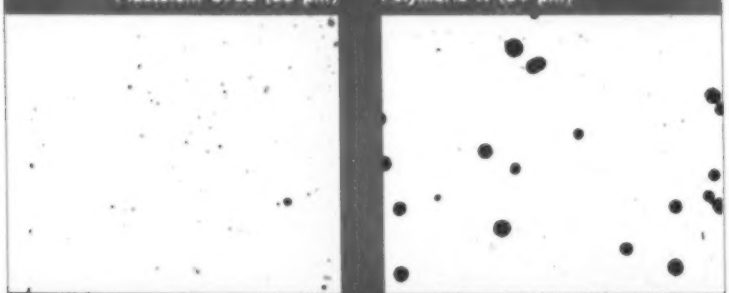
Plastolein 9722 (60 phr) | Plastolein 9720 (56 phr)



Plastolein 9730 (70 phr) | Di-octyl Phthalate (50 phr)



Plastolein 9750 (65 phr) | Polymeric A (64 phr)



Plastolein 9765 (68 phr) | Polymeric B (62 phr)

All tests performed by the South Florida Test Service. Formulation of all test samples was as follows:

Geon 101 EP	100 parts
Stabilizer	3 parts
Plastolein 9232 Epoxy	4 parts
Plasticizer	As noted

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Vopcolene Division, Los Angeles, Calif.,
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EY-O-178

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MODERN PLASTICS

June 1961 Volume 38, Number 10

Don't count out the custom molder

In the midst of the revolution through which the plastics industry is now passing, with mergers, integration, diversification the order of the day, a surprising strength is becoming apparent in our custom molding enterprise.

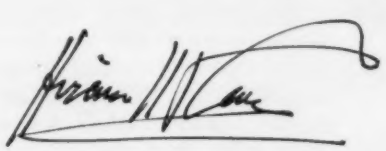
This is a new type of custom molder, and his strength is based on business acumen and engineering ingenuity. He enters the business deliberately, and with a cool head pinpoints his objectives: to do things with plastics that few others can do as well—or as economically.

As our molding materials become more sophisticated, more precise in properties, more exacting in engineering demands, this new-type custom molder establishes himself as an expert in precision production with the latest materials. He leaves to the captive plants and stodgy competitors the cheap and easy jobs and concentrates on the challenging new copolymers, terpolymers, quadripolymers, and alloys which baffle those who haven't kept up with the literature.

He is a respected consultant to his customers, rather than a servant. He is a technical leader, not merely a service function. And, because he works with high-cost raw materials, his mark-up is proportionate and he makes a profit, plus frequently an engineering fee. He opens the doors to the future of plastics.

This new-type custom molder stands on his own two feet. He demands a discount for cash rather than ask for credit. He is not married to obsolete methods or machinery. To the makers of raw materials he is a boon, not a burden. In technical conclaves he stands up and is counted, and is listened to. He contributes to the science, the engineering, and the literature.

Ten years ago, when customers of custom molders began to establish captive plants, the death of custom molding was predicted. And many custom molding concerns died or were absorbed according to prediction. Then came a host of new and difficult materials, a series of new engineering concepts, a recognition of the importance of custom enterprise as a provider of know-how. Out of all these elements was created the new-type custom molder!



NEW ADDRESS: Executive, Editorial, and Advertising headquarters offices of MODERN PLASTICS are now located in our new building at 770 Lexington Ave., New York 21, N. Y. Telephone and teletype numbers remain the same: Phone, PLaza 9-2710; teletype, TWX-NY 1-3063. Cable address: "Breskinpub, New York."

Reinforced molding compounds

Such advantages as those accruing from the use of reinforced thermoset molding compounds in the products illustrated in this article have established these materials as serious contenders for individual product markets within the automotive, electrical and electronic, housing, appliance, and other fields. Some idea of their current status can be gleaned from the 1960 estimates for premix, which is but one type of reinforced molding material. It has been estimated that automotive applications accounted for 30 million lb. of premix last year, electrical applications for 3 million lb., appliances for 1 million lb., various corrosive service uses for 750,000 lb., and miscellaneous uses for 2 million pounds. These figures are for compounded materials, but even so, the 25 to 30% of thermosetting base resin represented in these figures makes up a healthy market for the resin suppliers.

From the early days of their introduction to industry, reinforced thermoset molding compounds have always been noted for the high degree of strength and thermal resistance they could offer. More recently, largely because of the impetus provided by the nation's aerospace program, these properties have been even further upgraded. Today, compounds with quartz or other silicone reinforcement can provide superior ablation resistance at temperatures of up to 10,000° F. for short-time exposures.

However, these "way-out" properties come at a high price; some of the materials for the rocket and missile field are currently priced within a $3 to $20/lb. range.

To meet the more "down-to-earth" demands of the industrial end-user, the suppliers of reinforced thermoset molding compounds have taken a middle course that emphasizes lower-cost compounds and formulations that can upgrade properties other than physical and thermal. Thus, while strength and thermal resistance remain high, greater stress is now placed on better electricals, improved corrosion resistance, improved surface finish, better moldability, and higher quality and performance predictability in the molded part. In premix molding compounds, for example, growing usage of the bisphenol A type of polyester resin has greatly improved corrosion resistance in many industrial products. Tests conducted in various corrosive media have shown that the bisphenol A polyesters have greater flex strength retention than general-purpose and isophthalic polyester types. Tests have also shown that the heat stability of bisphenol A polyester is greater.

Development of reinforced compounds offering high arc and track resistance in the molded part have come about largely through the use of alumina and other silicate fillers. Upgraded electrical properties have also resulted from better moldability, which reduces the occurrence of internal voids and external cracks in molded parts.

New compounds, new methods

The roster of materials available for industrial uses has been augmented in recent years by reinforced epoxy and diallyl phthalate (DAP) compounds. Both compounds have emanated from developments within military and aerospace fields. Among many excellent properties, the two that stand out for both materials are superior electrical properties and good dimensional stability.

The recent development of a plasticizer (toluene sulfonamide) to replace chemical water in parts molded from reinforced melamine compounds eliminates potential cross-linking sites and minimizes internal stressing. And the plasticizer reduces post-molding shrinkage, and has reportedly improved the dimensional stability of reinforced melamine parts by about 30 to 40 percent.

In alkyd and polyester molding compounds, better flow and surface uniformity have been attained today by the use of high strand integrity chopped glass. This reinforcement, with its improved flow characteristics, resulting in stronger knit lines, has made possible the molding of relatively thin-wall parts that were previously impractical because of glass strand degradation as well as poor distribution of the reinforcement throughout the part.

Better flow in the reinforced thermoset com-

win new markets

Reinforced thermoset molding compounds today are bidding for several lucrative product markets, backed by solid evidence that they can lower unit costs, reduce number of parts, cut product size and weight, and combine these factors with outstanding properties and characteristics. Here are some recent applications:

pounds is also accomplished today by the use of radio-frequency, or dielectric, heating of preforms prior to molding. Pre-heating partially reduces the volatile content in the compounds, shortens molding cycles, and reduces molding pressure requirements. Another recent refinement in method is the heating of premix constituents during mixing operations. This "hot batch" method of mixing not only permits high strength values, but also finished parts reportedly have an excellent surface appearance.

Quality control has come a long way since the first days of the reinforced thermosets. One large compounder uses recording devices to meter quantity of compound ingredients and to insure uniform mixing, while constant test controls measure such factors as resin reactivity when received from supplier, oil absorption characteristics of fillers, and flow characteristics. The growing use of such procedures has resulted in the more predictable performance of products molded from the reinforced compounds.

Because of all these recent improvements, end-users today have an excellent chance of obtaining reinforced thermoset molding compounds with the properties necessary to meet their most exacting product requirements. Composite properties of the six most commonly used compounds are listed on page 84.

Resins and reinforcements

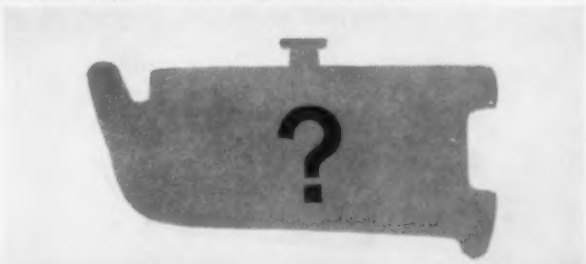
A great number of companies engaged in the supply of reinforced thermoset molding compounds feel that a distinction should be made between the types of compounds available. Generally speaking, two such types are mentioned: 1) molding compounds in which chemical reaction, segregation control, or impregnation are not attempted during the mechanical mixing operations; and 2) molding compounds in which a definite

● **Reinforced thermoset insulators, which have reduced weight of circuit-breaking electrical connectors by 80 percent.**

● **A switch housing, redesigned in a reinforced thermoset at about one-half the size of a cast iron counterpart.**

Photos, Food Machinery & Chemical Corp.

● **An automobile radiator tank produced for 66% of the cost of the present metal unit—an application so new that no photographs have been as yet released by its developers.**



chemical bond is effected during compounding. Many firms which offer compounds for sale state that complex problems and, often, misapplications can occur when end-users have easy access to premix formulas and ingredients, and purchase them separately for captive formulation. Moderating this position to some degree is the fact that a great deal of material and process sophistication exists today on the part of the "do-it-yourself" formulators and molders.

In basic makeup, however, all reinforced thermoset molding compounds are similar, consisting of base resin, reinforcement, and inert fillers. Base resins used include: phenolic, melamine, epoxy, a small amount of urea, silicone, alkyd, and diallyl phthalate. Unsaturated polyesters are the primary resins for premix, although some phenolic resins have also been used.

A broad range of reinforcements is available for use today. Included are sisal fibers, glass fibers (¼- and ½-in.), asbestos fibers, quartz, carbon fibers, and such synthetic materials as nylon staple fibers, scrap nylon rag, and Orlon and Dacron fibers. Natural bark fiber has been a new development, and is primarily of interest in low-cost formulations.

Premix materials in a form ready for molding may consist of either a wetted, doughy mass or an extruded "rope" or "log." Other reinforced thermoset molding compounds may take the form of dry powder, granules, flakes, or pellets. Another typical material within this latter type consists of small squares chopped from resin-impregnated reinforcing cloth, such as glass cloth, silica fabric, carbon cloth, and others.

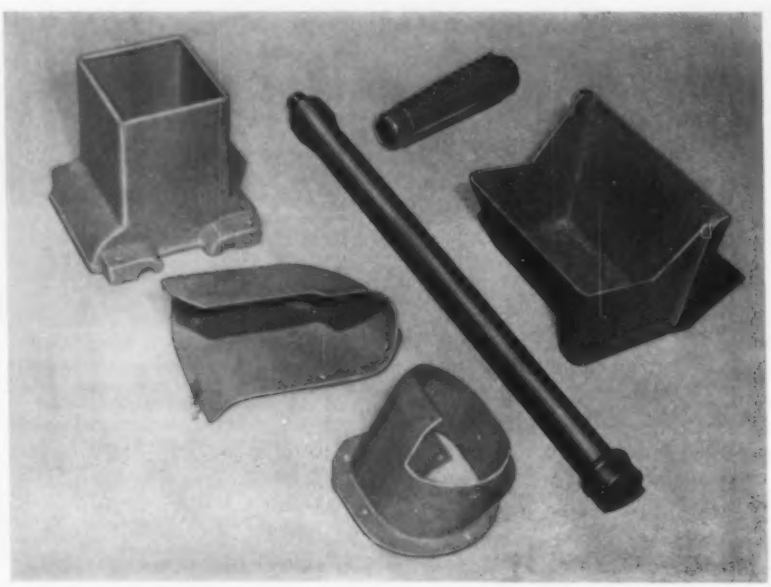
Application fields

Automotive: This forward-looking industry has been of overwhelming importance to the growth of reinforced thermoset molding compounds. Past model years have seen the introduction of such applications as: premix housings and ducts for heaters and air conditioning units; reverse clutch cones of high-strength glass-phenolic construction; oil pump gears of glass- or asbestos-reinforced phenolic; and electrical insulators molded from glass-reinforced melamine compounds.

And now . . . great excitement has been generated by reports that one of the "Big Three" auto makers will soon turn to glass-reinforced bisphenol A polyester premix for the radiator reservoir tank sketched on p. 81.

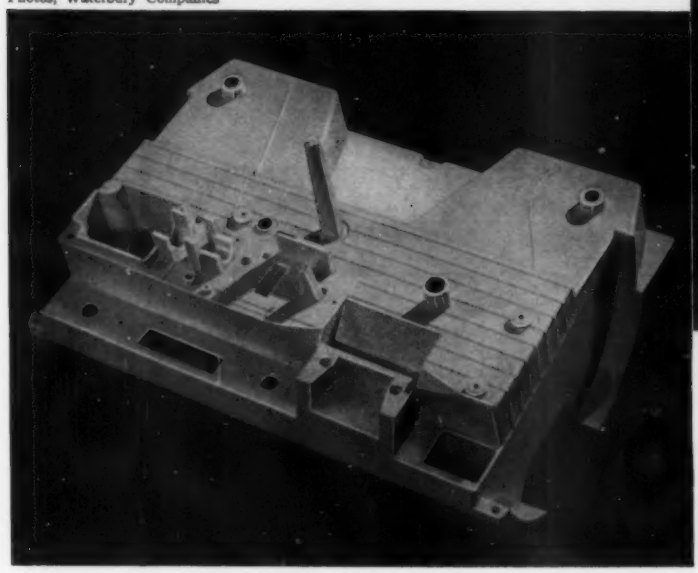
Improved functional performance due to shape factors easily obtained with a molded part, along with excellent corrosion resistance, will be prime features of the new tank. High strength is also said to have been a factor behind the switch from brass to premix. The premix tank will withstand vibration far better than the brass tanks, which often came apart at the seams, and it has outperformed brass tanks in static burst strength tests. The new tank weighs only 2½ pounds.

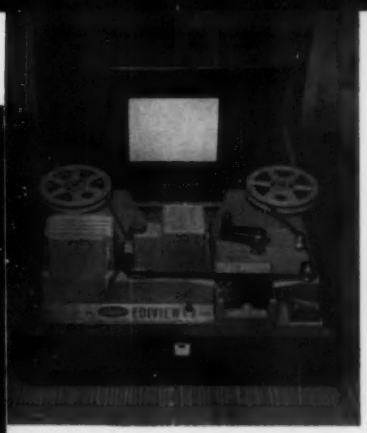
Another cost-cutter in the automotive field is an asbestos-phenolic gear for use in the Buick



PRODUCTS MOLDED from reinforced compounds cover a wide range of uses. Long rod is a pump component; around it, clockwise from top, are: handle of outboard motor control (Harry Davis Molding Co., Chicago), hopper for vending machine (this and other items by Imperial Molded Prods., Chicago), mated halves of a truck heater system, and a hopper for a hamburger machine.

Photos, Waterbury Companies





HOUSING for film editor-viewer consists of three sections made of glass-polyester compound. Complete unit is shown above; at left, complex molding for largest of three parts is shown, with mounting holes and strengthening ribs molded in. High-temperature resistance of compound is important because of heat thrown off by viewing lamp.

transmission systems. In this application, the elimination of machining to produce the gear teeth, plus the adaptability of the reinforced compound to large-volume, automatic molding, has resulted in a 17¢/unit saving over metal gears.

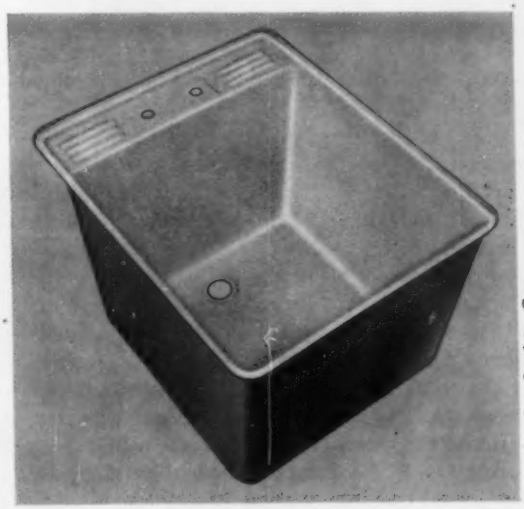
The reinforced thermoset molding compounds have also racked up cost savings in such auto components as motor commutators, where a reinforced medium-impact phenolic section, molded automatically around a copper insert, has reportedly cut part cost in half, and piston bushings for General Motors' torsion bar suspension system, where graphite-filled high-impact phenolic eliminates the need for sealed-in lubrication.

The strength of glass-reinforced polyester premix is a major factor in its selection for a new car-roof luggage carrier. The carrier is said to be practically destruction-proof, both from hard knocks and from weathering.

Physical strength is combined with heat resistance in premix components for the heater assembly in International Harvester trucks. Unlike metal counterparts, several joining holes in the mated premix heater parts can be cored in the mold, rather than drilled after molding.

Electrical and electronic: There is a great demand in the electrical industry today for smaller parts capable of handling higher power loads. Those reinforced thermoset molding compounds that have been improved in electrical properties have gone a long way toward meeting the demand. One definite trend has been the redesign of heavy (10 to 20 lb.) electrical components, consisting of load-carrying metals with separate insulation, into lower-weight, lower-cost reinforced thermoset parts that can combine the load-bearing and insulating functions.

Reinforced epoxy and diallyl phthalate compounds are particularly useful in electrical applications. The epoxies are widely used for molded encapsulation of electrical and electronic coils, resistors, and switches. In this area, they compete with epoxy potting methods, over which they offer better protection to the encapsulated part and less chance of internal voids. And tremendous cost savings are claimed for them: one 8-cavity mold



Photo, American Insulator Corp.

PREMIX LAUNDRY TUB has received popular reception. Premix provides tub with integral color and large weight saving over concrete.

Property value ranges of six commonly used reinforced thermoset compounds

Property	*Phenolic*	*Epoxy*	*Melamine*	*Diallyl phthalate*	*Alkyd*	*Polyester premix*
Specific gravity	1.25 to 2.0	1.3 to 2.0	1.5 to 2.0	1.34 to 1.88	1.85 to 2.1	1.4 to 2.3
Tensile strength, p.s.i.	5,000 to 18,000	5,000 to 18,000	5,000 to 10,000	4,600 to 9,500	5,000 to 9,000	5,000 to 10,000
Compressive strength, p.s.i.	17,000 to 35,000	15,000 to 25,000	20,000 to 38,000	25,000 to 30,500	20,000 to 30,000	13,000 to 27,000
Flexural strength, p.s.i.	10,000 to 30,000	8,000 to 30,000	7,000 to 22,000	8,500 to 19,000	12,000 to 17,000	6,000 to 26,000
Flexural modulus, p.s.i.	0.5×10^6 to 3.0×10^6	0.7×10^6 to 2.2×10^6	0.7×10^6 to 3.0×10^6	0.64×10^6 to 1.4×10^6	1.9×10^6 to 2.5×10^6	1.5×10^6 to 2.5×10^6
Impact strength, ft.-lb. per in.	1.0 to 20.0	0.3 to 15.0	0.7 to 15.0	0.4 to 9.0	2.0 to 12.0	1.0 to 15.0
Hardness (Barcol)	50 to 90	50 to 60	45 to 70	———	70 to 80	60 to 90
Moisture pickup, %, 24 hr. @ 23°C.	0.1 to 2.0	0.05 to 0.8	0.2 to 1.0	0.1 to 0.4*	0.07 to 0.15	0.05 to 0.2
Burning rate	Slow to none	Slow to none	None	Slow to none	Slow to none	Slow to none
Heat resistance, °F. (continuous)	250 to 450	450 (max.)	250 to 400	300 to 450	300 to 325	250 to 450
Resistance to acid and alkali	Poor to excellent	Good to excellent	Poor to excellent	Good to excellent	Poor to excellent	Fair to excellent
Solvent resistance	Excellent	Excellent	Excellent	Excellent	Excellent	Good to excellent
Machining qualities	Poor to excellent	Fair to excellent	Good	Good to excellent	Good	Good
Dielectric constant, 1 Meg.	4.0 to 8.0	3.0 to 4.1	5.0 to 7.5	3.3 to 5.2	4.5 to 6.0	4.0 to 6.0
Dielectric strength, v./mil	90 to 450	300 to 450	250 to 350	350 to 430	350 to 400	200 to 400
Arc resistance, sec.	5 to 180	125 to 185	125 to 210	115 to 190	120 to 185	160 to 190
Volume resistivity, ohm-cm.	10^9 to 10^{15}	10^{15} to 10^{16}	10^{10} to 10^{13}	10^7 to 10^9	10^9 to 10^{11}	10^{12} to 10^{13}

*48 hr. @ 122°F.

for encapsulation is said to be the equivalent of 100 potting fixtures! Reinforced compounds with a diallyl phthalate resin base are said to maintain high dielectric values under high humidity and temperature. The low shrinkage of these materials during final cure makes them well-suited for insert molding.

Size and weight reduction have been the features in the use of asbestos-DAP insulators in circuit-breaking electrical connectors. Redesign in this material has enabled one manufacturer to cut insulator size in half, and to reduce connector weight by about 80 percent.

A manufacturer of speed-sensing switches, used for safety or control on motor-driven machinery, machine tools, and conveyor lines, has replaced housings of cast iron with glass-polyester premix housings. The result, because of the excellent dielectric properties of the premix, is a case measuring 3½ by 3¼ in., compared with 5½ by 5⅛ in. for the cast iron housing. In addition, assembly time has been reduced and total mold costs were about $11,000 lower than those for die casting aluminum—the other material considered for the housing—and another $3000 to $4000 has been saved by the elimination of hand-made prototypes for die casting.

The fabulous field of electronics computing devices has also been penetrated by reinforced thermoset molding compounds. As an example, glass fiber-reinforced phenolic, supplied in granular form, has replaced unfilled thermosetting plastic materials in the memory core frame of several I.B.M. computers. The prime reason for the changeover was better dimensional stability, while other plus factors have been high impact and flexural strength, minimum shrinkage, high dielectric strength, and high heat resistance.

Glass fiber-reinforced alkyd molding compounds find their widest usage in the electrical and electronic field. Such applications include vacuum tube bases, circuit breakers, computer components, and switch gear components.

Housings: Within the past year, a general-purpose electronic computer, designed for desk-top operation, has made its market debut in a premix housing. The company producing the computer has cited these comparisons with aluminum housings: 50% lighter weight; better protection of the computer mechanisms; less **(To page 172)**

For hot-foods vending:

Molded tray withstands 450°F.

An unpretentious-looking molded tray bids fair to bring to the vending industry a market expansion undreamed of by even the most optimistic seers, an expansion that could conceivably result in a rate of consumption of 18,000,000 of these trays *per day*.

Behind this prospect lies the exciting concept of *machine-vended hot meals*. Vending by and large has meant sandwiches and, with a few exceptions, cold foods. Now, through the new tray and the use of the so-called radar range, all this is changed. The radar range can heat a meal in 90 sec., and the new tray is suitable for use in radar ranges. Thus, by making the radar range part of a vending system, the mass dispensing of hot foods can now become a reality, pushing vending to its full potential. (The new tray is also said to be suitable for use in standard gas or electric ovens.)

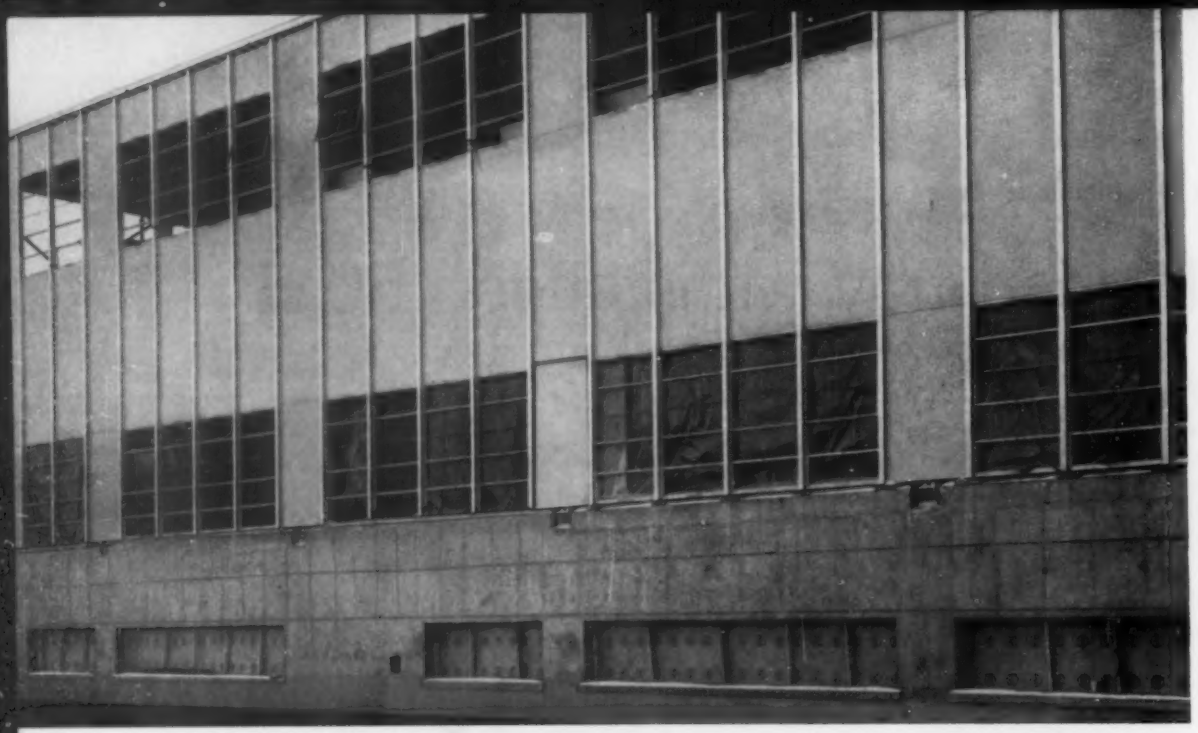
Considerable secrecy surrounds the nature of the tray. The manufacturer, Haveg Industries Inc., Wilmington, Del., has disclosed neither its exact material composition nor precisely by what technique it is produced. However, industry observers who have had a chance to examine the product are generally agreed that the material is essentially a melamine-impregnated paper, molded into final shape on **(To page 177)**

MOLDED TRAY is slipped into restaurant radar range. Frozen food can be heated to the proper temperature in only 90 seconds.

Photos, Haveg Industries Inc.

FOOD is served in same tray, which—with polyethylene-coated cellophane cover—also acts as shipping package.

BASIC DESIGNS of trays that are shown in the photo at left are supplemented by special shapes for restaurants and vendors.



TESTING LABORATORY of U. S. Steel Corp. at Homestead, Pa., utilizes curtain wall of modular steel panels filled with self-extinguishing polyurethane foam. Panel in color is of size shown being processed at right.

Progress in self-extinguishing

In a major development that may have significant implications to the success of plastics' penetration of the lucrative building and transportation markets, urethane foam has now been made integrally self-extinguishing without adverse effect on its other desirable properties.

Flame-resistant urethane foams have been on the market for some time. But this resistance was obtained through the use of additives which reportedly may have had the effect of weakening the foam or impairing its aging characteristics.

The new foam is produced by combining a hydroxyl-rich alkyd resin with a semi-prepolymer containing toluene diisocyanate. Fire retardance is built into the basic chemistry of the foam by incorporating chlorine-rich Het acid in the resin and prepolymer, and making it part of the over-all molecular structure of the foam.

Among the initial users of the new foam system are American Bridge, Div. of U. S. Steel Corp., which foams this urethane between two thin sheets of steel to produce wall and door panels for its AmBridge modular building; and Toyad Corp., Latrobe, Pa., which is producing rigid slab stock and molded shapes under the tradename Chemfoam RSF. Both companies use trichlorofluoromethane as the blowing agent.

In its Harrisburg plant, American Bridge fills the panels by continuous foaming. The steel "skins" are placed in a mold and preheated for 15 min. so that they are at 165° F. when filled with foam. Fifteen minutes after the hot molds have been filled, the material is thoroughly cured and molds may be opened. The panels provide exterior walls for the new 2½-story U. S. Steel testing laboratory, a 200- by 500-ft. structure now nearing completion at Homestead, Pa.

The U. S. Steel laboratory contains two floors and a penthouse. First, a steel frame was erected; to this were attached lightweight stainless steel mullions. The foam-filled panels were then bolted to these mullions. Since each panel is pre-shaped to proper size, it can be set in place in a few minutes. According to U. S. Steel, these panels were specified because of their load-bearing quality, strength, heat insulation, and fire-resistance. Selection was also based on several additional

FOLLOWING PREHEATING for 15 min., mold with steel skins for the panel is pulled toward continuous foaming machine at American Bridge plant. At foaming station, the mold is clamped prior to its being filled with foam.

urethanes

factors. Among these were the strong adhesiveness of foam to metal, the rigidity and flatness of the panels, and that the use of the thin panels also gives more room, up to 5% additional floor space—at equivalent heat insulation value—than if masonry construction were used.

Toyad slab stock, available in densities between 2 and 6 lb./cu. ft., is priced competitively with polyester urethanes rendered fire-retardant with additives, and is foamed by machine processing. The foam is made in large buns. The foaming reaction is exothermic and occurs at room temperature. After being stored overnight, the cured foam is sliced to desired thickness. Shaped products are made in molds preheated to 150 to 155° F. A post cure of 20 to 30 min. completes the process. Mold release is accomplished easily with agents specifically designed for this purpose.

Markets foreseen by Toyad are insulation for cold storage chambers, pipes, tanks, truck trailers, railroad cars, appliances, and air conditioning. Toyad is also engaged in developing markets in packaging, RP, and buoyancy applications.

Credits: Ingredients for self-extinguishing foam and Het acid supplied by Durez Plastics Div., Hooker Chemical Corp.—**End**

PANEL HAS BEEN FILLED with foam, seen rising here at top. This indicates completion of fill. In addition to flame resistance, foam offers good adhesion to steel and contributes to overall structural strength of panel.

Photos, Durez Plastics Div., Hooker Chemical Corp.

CHOOSING COLORANTS

One of the major reasons for styrene's popularity and acceptance in the area of consumer products is, of course, its colorability. And as modern merchandising techniques place greater emphasis on visual appeal, the importance of coloring grows stronger.

To the processors and end-users involved with styrene, this means that a constant awareness of the type of colorants available and recommended for polystyrene is essential to a good job. While it is basically true that the dyes and pigments used today are practically the same as were known some 40 years ago, there have been some important changes. One or two new families of colorants have been introduced—the phthalocyanine pigments in 1930, the quinacridone pigments within the past few years. Many of the dyes and pigments initially screened for coloring styrene have been improved or modified so they can be incorporated into the plastic with comparative ease, *e.g.*, some of the vat pigments.

Styrene formulations have also been modified radically over the years. General-purpose polystyrenes are supplied crystal-clear and may be colored in the full range of the spectrum in both transparent and opaque effects. Because they are either translucent or opaque in the natural state, rubber-modified high-impact types have a more limited color range. Heat- and chemical-resistant types which are not water white at present still have broad color possibilities as transparent and opaque products. The other variations of styrene —expanded and expandable polystyrene, light-stable polystyrenes, and fibrous glass-reinforced polystyrenes—are limited in their use of colorants as temperature and end-use requirements dictate.

When selecting a suitable colorant for any

*General Aniline & Film Corp., New York, N. Y.

COLORANTS RECOMMENDED

TYPE OF COLORANT	COLOR INDEX	CI NUMBER
YELLOW		
Soluble dye		
—	Solvent yellow 43	—
Monoazo	Solvent yellow 2	11020
Disazo	Solvent yellow 29	21230
Monoazo	Solvent yellow 3	11160
Monoazo	Solvent yellow 1	11000
Monoazo	Solvent yellow 7	11800
Monoazo	Solvent yellow 23	—
Quinoline	Solvent yellow 33	47000
—	Solvent yellow 40	—
Inorganic pigment		
Cadmium sulfo-selenide	Pigment yellow 37	77199
Strontium yellow	Pigment yellow 32	77839
Zinc chromate	Pigment yellow 36	77955
Nickel-titanium yellow	—	—
Organic pigments		
Nickel-azo	—	—
Vat (anthraquinone)	Vat yellow 1	70600, 70601
Vat (anthraquinone)	Vat yellow 2	67300, 67301
ORANGE		
Soluble dye		
Monoazo	Solvent yellow 14	12055
Monoazo	Solvent orange 7	12140
Monoazo	Solvent orange 1	11920
Inorganic pigment		
Cadmium sulfo-selenide	Pigment orange 20	77199, 77196
Organic pigment		
Vat (anthraquinone)	Vat orange 3	59300, 59301
Vat (anthraquinone)	Vat orange 7	71105

TYPE OF COLORANT	COLOR INDEX	CI NUMBER
RED AND MAROON		
Soluble dye		
Anthraquinone	Solvent red 52	68210
Disazo	Solvent red 24	26105
Disazo	Solvent red 22	21250
Monoazo	Solvent red 4	12170
—	Solvent red 64	—
—	Solvent red 65	—
—	Solvent red 66	—
—	Solvent red 67	—
Inorganic pigment		
Cadmium sulfo-selenide	Pigment red 108	77196
Organic pigment		
BON (2B Ca salt)	Pigment red 48	15865
Pigment scarlet	Pigment red 60	16105
Vat (anthraquinone)	Vat red 10	67000, 67001
VIOLET		
Soluble dye		
Anthraquinone	Solvent violet 13	60725
—	Solvent violet 14	61705
—	Solvent violet 16	—
—	Solvent violet 17	—
Inorganic pigment		
—	—	—
Organic pigment		
Carbazole	—	—
GREEN		
Soluble dye		
Anthraquinone	Solvent green 3	61565

FOR POLYSTYRENE

By E. A. Wich*

plastic, there are usually three major considerations: stability to heat at the temperatures necessary for molding or extruding; light fastness; and resistance of the colorant to bleeding into decorative coatings or into the solvents used to join plastics parts together.

The choice of colorants for polystyrene is somewhat simpler than for some other plastics, because polystyrene is essentially inert and unplasticized. One seldom has to contend, therefore, with side effects due to residual catalysts or with an appreciable solvent action which can induce chalking. As a result, it is safe to say that breakdown of color during the processing of polystyrene is almost entirely due to the effect of heat.

There are three basic classes of colorants suitable for coloring polystyrene: dyestuffs, organic pigments, and inorganic pigments.

Certain oil-soluble or hydrocarbon-soluble dyes have been found satisfactory; their chief use, however, is for transparent effects. When these dyes are used for transparent articles, the fastness to light is generally adequate. If they are used for opaque molding purposes by incorporating into the formulation a small percentage of titanium dioxide, the degree of fastness diminishes considerably. It is for this reason that pigments are preferred to dyes for opaque shades.

Organic toners are recommended where dielectric constants are of importance, since their dielectric properties are better than the dyes or inorganic pigments. Many pigments at low concentration will give sufficient transparency with clean, bright, intense coloration.

The tables on these pages list colorants recommended for use in polystyrene. Where the end-user definitely knows his specific requirements, he is recommended **(To page 180)**

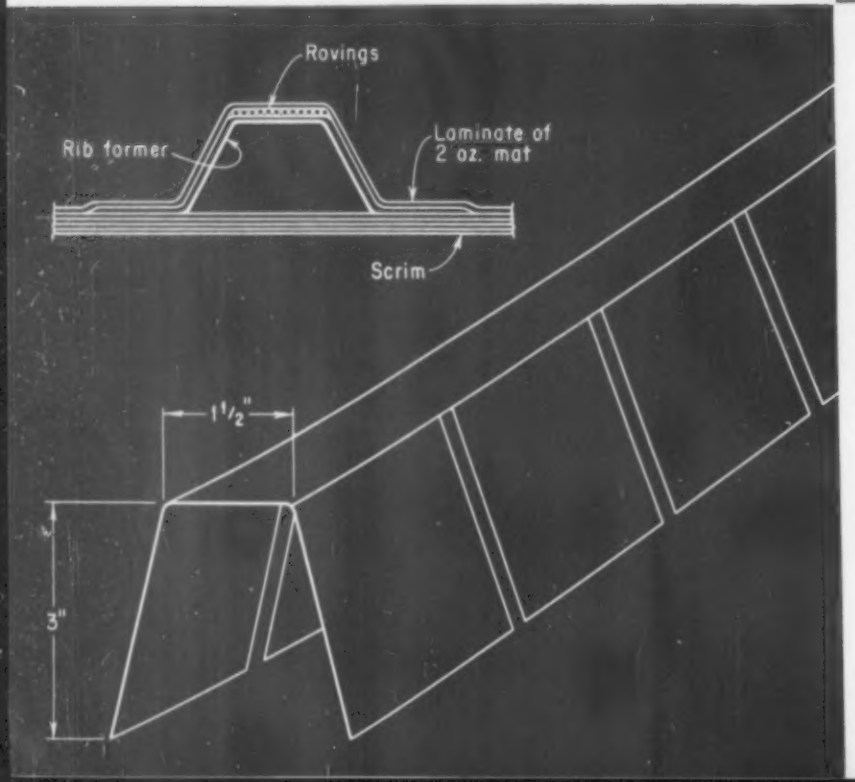
FOR USE IN POLYSTYRENE

TYPE OF COLORANT	COLOR INDEX	CI NUMBER
Inorganic pigment		
Chromium oxide	Pigment green 17	77288
Hydrated chromium oxide	Pigment green 18	77289
Chrome green	Pigment green 15	77520 + 77600, 77601 or 77603
Organic pigment		
Phthalocyanine	Pigment green 7	74260
BLUE		
Soluble dye		
Anthraquinone	Solvent blue 11	61525
Anthraquinone	Solvent blue 16	—
Anthraquinone	Solvent blue 20	—
Inorganic pigment		
Ultramarine	Pigment blue 29	77007
Iron blue	Pigment blue 27	77510, 77520
Cobalt blue	Pigment blue 28	77346
Organic pigment		
Phthalocyanine	Pigment blue 15	74160
Phthalocyanine	Pigment blue 16	74100
Vat	Vat blue 6	69825, 69826
Vat	Pigment blue 21	69835
BROWN		
Soluble dye		
Azo	Solvent red 40	—
Azo	Solvent brown 11	—
Monoazo	Solvent brown 1	11285
Monoazo	Solvent brown 9	—
—	Solvent brown 15	—
—	Solvent brown 16	—
—	Solvent brown 22	—
Inorganic pigment		
Iron oxide	Pigment brown 6	77491, 77492, 77499
Organic pigment		
Vat (anthraquinone)	Vat brown 3	59300, 59301
BLACK		
Soluble dye		
Azo	Solvent black 12	—
Inorganic pigment		
Iron oxide	Pigment black 11	77499
Channel	Pigment black 7	77266
Lamp	Pigment black 6	77266
Bone	Pigment black 9	77267
Organic pigment		
—	—	—
WHITE		
Soluble dye		
—	—	—
Inorganic pigment		
Titanium dioxide (Rutile & anatase)	Pigment white 6	77891
Zinc oxide	Pigment white 4	77947
Antimony oxide	Pigment white 11	77052
Organic pigment		
—	—	—

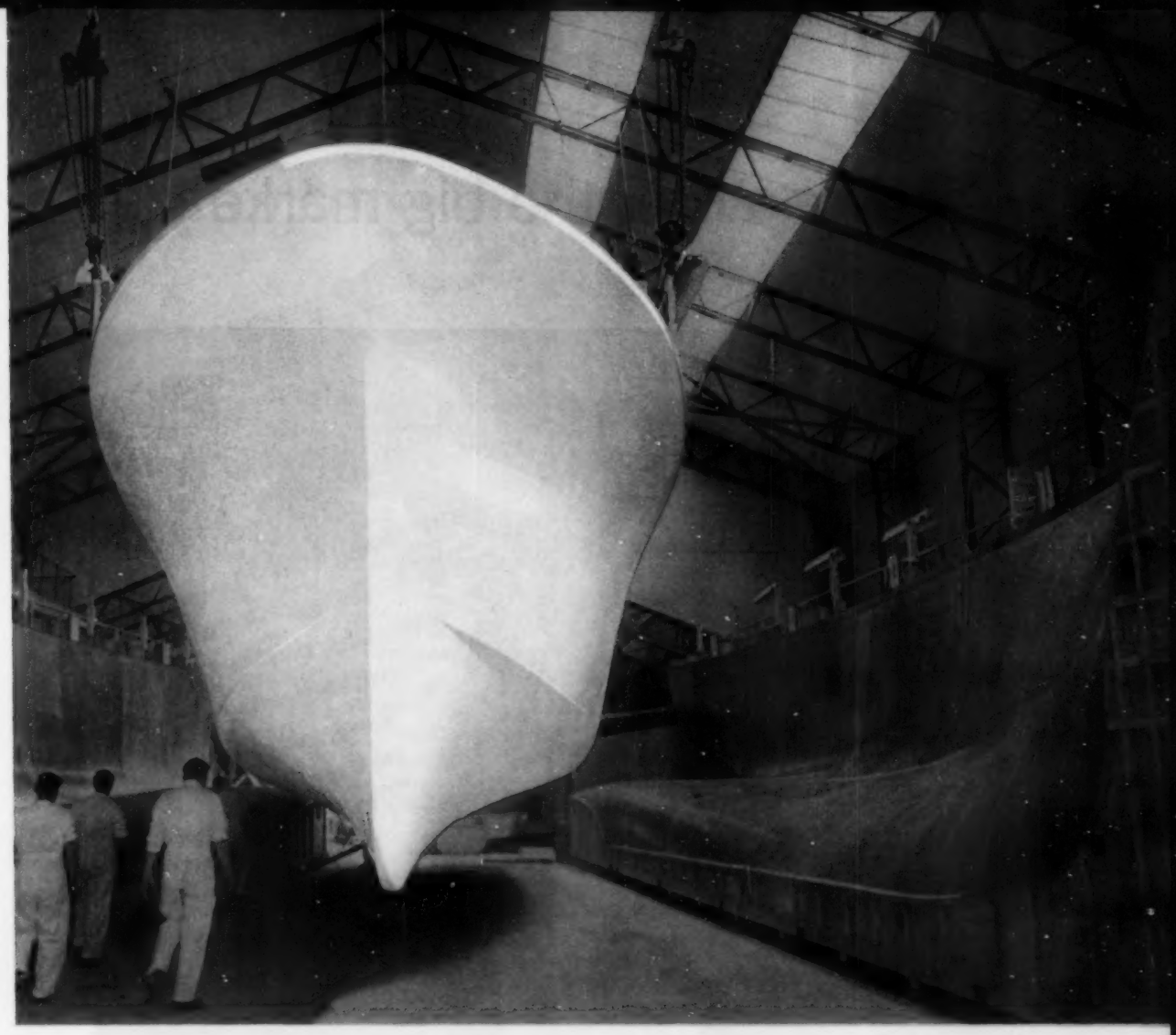
One-piece RP hull– 67 ft. long!

Hull's size points up potentials for RP in building larger ocean-going vessels

Key to success of hull's design is low-cost technique for molding in integral framing



REINFORCEMENT FRAMES are integrally built into the hull by novel method: 1) paper or aluminum strips (left) are slit along side at 1-in. intervals, bent into "U" shape, and then curved to fit against inside of hull; 2) bases provide no structural strength, are merely shape against which RP frame sandwich of mat/roving/mat (top left) is laid up to form rib frames superior in strength to timber type.



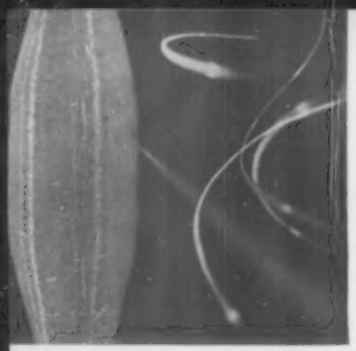
If your thinking on the future for reinforced plastics in the boat-building industry has progressed beyond the obvious markets for the material in small boats up to the 25-ft. length, then you're ready for the announcement that a 67-ft. hull has been produced in reinforced plastics and was launched last month for use as a pleasure yacht. And that's a lot of boat!

As completed, the yacht measures 67 ft. long by 16 ft. 4 in. wide, and stands some 14 ft. high at the bow. The hull, which is claimed to be the largest one-piece integrally-framed RP unit thus far made, weighs some 11,500 pounds. Known as the Alden/Halmatic Ocean Commander 67, the boat will have a displacement of about 28½ tons.

Why reinforced plastics?

Beyond the obvious reasons for choosing RP —its corrosion resistance, ease of maintenance, and light weight—the boat builders felt that the use of the material gave them a design flexibility —all but impossible to duplicate in wood—that resulted not only in a sleeker, more streamlined boat, but also in a better and more economical one as well.

For example, integral fuel and water tanks are molded directly into the hull (and later fitted out with aluminum alloy covers), as are the contours or angles into which the wooden bulkheads are bonded—a feature that adds to the over-all strength of the boat. Recognizing the fact that the glass-polyester construction, while very strong, is also flexible, the boat builders further utilized RP's designability to stiffen the hull with molded-in hollow transverse framing similar to the framing used in wooden hulls. Only with RP, this resulted in a hull considerably stronger, although equally as rigid, as a comparable wooden timber hull of the same weight. The hollow frames used on the 67-ft. hull are 3 in. wide **(To page 188)**



THE COVER: Running the color gamut from soft pastels to vibrant hues, these polypropylene monofilaments are spreading into a broad range of end use applications. Filaments shown courtesy Firestone Synthetic Fibers Co. and Dawbarn Bros. Inc.

Why the big market for

Photo, Dawbarn Bros. Inc.

LARGE-DIAMETER ROPE shown on massive horizontal layer at plant of American Manufacturing Co. Inc.

HMS QUEEN MARY being pulled out of its pier and into the Hudson River on its way to Europe. Sailor aboard harbor tug is snubbing hawser on deck bitt. Hawser consists of a nylon core, polypropylene main body, and polyester sleeve.

polypropylene monofilaments?

Price and performance.

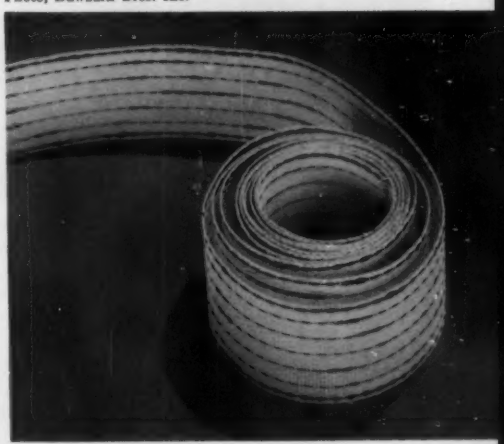
This, say the resin suppliers, is the capsule story behind polypropylene's success in the monofilament field, the reason behind the fact that about 10 million lb. of the resin (33% of total consumption) went into monofilament in 1960, and the basis for industry estimates that this figure may grow to approximately 40 million lb./year by 1965.

With a density of 0.90 to 0.91, lower than that of any other commercial resin used for monofilaments, polypropylene has the highest yield. For example, 1 lb. of the material will produce over 120,000 yd. of 3-mil-diameter monofilament. Yet, despite the low density, these filaments are among the strongest of man-made fibers. In terms of tenacity (which is a measure used by the textile industry to indicate the tensile strength of fibers, with higher figures indicating greater strength), the four most commonly used monofilaments compare as follows: polypropylene . . . 4.0 to 7.5; polyethylene, high density . . . 3.0 to 7.0; nylon 6, 6/6 . . . 4.0 to 9.0; and polyvinylidene chloride . . . 1.5 to 2.5. In addition, both polypropylene suppliers and monofilament extruders claim superior color fastness, no significant water absorption, good stiffness in thick sections, and several other desirable properties. However, they also realize that ultra-violet light resistance is still somewhat of a problem. While resin formulations and UV absorbers have been significantly bettered over early grades, it is generally agreed that further improvements are necessary. Work in this direction is being pursued vigorously at all levels, and monofilaments suitable for continuous outdoor use, even in areas of heavy sunshine, can be expected soon. In fact, some extruders claim that, properly stabilized and colored, it is already here.

Markets are growing

In the three years that polypropylene monofilaments have been commercial, they have taken over completely in several applications, have made substantial penetrations in others, and are about ready to take off in several more. Among the last are several interesting possibilities that are based on the fact that monofilament can be integrally molded with molding-grade PP resins. Arvin Industries' development of the molded on clip in connection with summer furniture webbing (photo, right) suggests similar molded applications. For example, grille cloth with a molded on frame for attachment to speaker cabinets, or perhaps entire cabinets with the grille molded in. Molded air conditioner units, with PP grille cloth integrally molded in . . . and there are numerous applications possible in the automotive field where molded in

Photo, Dawbarn Bros. Inc.



TYPICAL NARROW WEB woven from polypropylene monofilament for use on outdoor furniture. Note how width of dark fiber varies throughout the tape to produce a pleasing visual effect. This variation is achieved during the extrusion process and is not a function of the weaving operation.

LAWNCHAIR WEBBED with polypropylene tape. In addition to color stability, these tapes also offer the possibility of molded-in clips. Such clipped webbings, now in production, facilitate installation.

Photo, Firestone Synthetic Fibers Co.

Photo, Dawbarn Bros. Inc.

THREE EXAMPLES of novelty items produced of woven monofilament, all offering light weight to the user. Briefcase, belt, and eyeglass case are all woven of tan fiber, may find particular acceptance for use during the summer.

monofilament could produce interesting decorative effects in door panels, dash boards, and others.

Automotive seat covers: This market has, in effect, been saturated and currently consumes about 1 million lb. of resin per year. This is an area in which polyvinylidene chloride (saran) used to have almost unshakable position. The switch was simply due to the new material's better price and properties. In addition to being stronger, PP in seat covers also offers better color retention; and the ultraviolet light problem hardly enters the picture, since car body and windows keep much of this radiation from reaching the fabric. In addition to the replacement seat cover market, polypropylene monofilaments are also moving into original car upholstery, representing annually a potential 3 to 4 million pounds. Several manufacturers are now using the fiber as warp material, with a variety of other filler yarns making up the rest of the fabric. A number of 1962 model cars will have such original upholstery. There is also some talk about the entire fabric being made of polypropylene; however, this is only in the development stage right now.

Outdoor furniture webbing: This, too, is a market where polypropylene has scored impressively and is expected to become the dominant monofilament material. About 2 million lb. of resin went into this use in 1960, representing 40 to 50% of the full market potential. This percentage is expected to go to between 60 and 70% in 1961 (about 3 million lb.), and may reach a saturation point of over 80% before 1965. Again, the material being replaced is saran, with polypropylene offering lower cost and better color stability. However, this is an area where UV resistance presents a problem in certain parts of the country. Even when the material is UV-stabilized and properly pigmented, year-round exposure in the southern states may have a degrading effect, and saran can be expected to retain a foothold there, despite its color problem. It will change color, but will not degrade. Polypropylene resin producers are pursuing a cautious policy, lest misuse of polypropylene webbing in outdoor furniture tend to prevent full market development when effective UV absorbers make such usage sound.

Rope: Olefin makers have long eyed the rope field, particularly in the area of marine hawsers, and electrical line work as a promising outlet for their resin. In the case of polyethylene, success has been limited, reportedly because of strength factors. Total polyethylene consumption for rope in 1960 was about 1.5 to 2 million lb., generally confined to barrier-marking uses. Polypropylene seems to be faring somewhat better. Estimates for PP cordage consumption in 1960 range from 1 to 3 million lb., and 1965 consumption is expected to reach a 5-million-lb./year level, although estimates by some trade sources go as high as 10 million pounds.

New York harbor represents a typical case history. Four years ago, about 20% of marine hawsers were made of synthetic material, and the total hawser bill came to $80,000 per year. Today, 80% of all hawsers are synthetic. Of this, 60% are polypropylene; and the annual hawser expenditure is now down to $50,000.

The biggest competitor is manila, which, on a size-to-size-basis, is about three times less expensive. On a strength-to-strength-basis, this difference is reduced to a 1:1.5 ratio. And in terms of durability, polypropylene has the edge by a factor of about four. A representative cost comparison, furnished by one rope maker, follows:

Material	*Diam. size*	*Weight/ 100 ft.*	*Cost/ lb.*	*Cost/ 100 ft.*	*Min. strength*
	in.	*lb.*	*$*	*$*	*1000 p.s.i.*
PP	7/16	3.8	2.15	8.17	3.4
PE	1/2	5.3	1.94	10.28	3.6
Nylon	13/32	4.2	2.43	8.26	3.7
Dacron	7/16	6.5	3.52	22.90	3.475
Manila	9/16	10.4	0.69	7.20	3.45

Cost and service life, while of prime importance, are, however, only part of the story. Another important one is use convenience. This

relates to weight and has a bearing on the number of people necessary to handle a given rope. For example, manila rope with a 9-in. circumference is about the thickest that can be handled by one man. However, barges frequently require heavier rope than that, necessitating two men to handle it. This problem would not arise with polypropylene. The polypropylene industry also points out that PP rope cannot become waterlogged or change its properties because of water absorption.

One problem encountered with PP is frictional heat generated in maneuvering a ship. Under certain circumstances, this heat may fuse the polypropylene fibers, impairing their usability. To overcome this, one manufacturer, American Mfg. Co., Brooklyn, N. Y., now offers a PP rope whose outside shell consists of a blend of other fibers. The company states that it can actually custom blend rope to meet any user's requirement. Internal lubricants also aid in this problem.

Not only is PP rope moving strongly into the marine field, but it is also putting in a bid for electrical line construction usage. According to Petersen Engineering Co. Inc., Santa Clara, Calif., marketers of synthetic ropes, PP has the requisite electrical characteristics for this application, plus the necessary strength. It can be obtained at a cost comparable to wire rope for pulling lines. But, because of its extreme lightness, over-all savings can be realized.

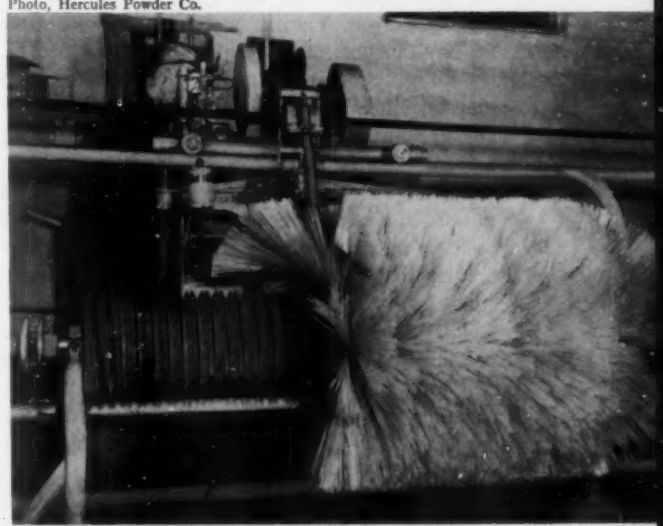
Municipal street sweepers: At the moment these sweepers represent one of the most exciting growth prospects for the polypropylene monofilaments. In 1960, this market consumed about 250,000 lb. of resin. By 1965, this is expected to grow to an annual rate of 1 million lb.—with some optimists foreseeing a resin consumption of close to 10 million lb. by that year. Some estimates place the yearly potential at close to 10 million lb. of resin. In this application, the filaments are used as bristles in the big rotary brooms of mechanical sweepers, with each vehicle carrying between 150 to 200 lb. of bristles. The oval-shaped filaments are cut to approximately 22-, 24-, and 26-in. lengths by the extruder and supplied in this form to the broom refillers. He folds them in half, inserts them in cable, and winds it around a metal core on the sweeping machine. (Photo, top right.)

Right now, polypropylene's share of this market can best be described as minor, but both resin suppliers and extruders have high hopes. And they base their optimism on the price and property advantages polypropylene offers.

The resin competes with natural fibers (palmyra stalks, hickory, bass), metal fibers, and other plastic filaments (primarily nylon and polystyrene). Not counting the core, the cost of natural bristle per sweeper broom runs between $35 and $65.

Polypropylene bristles, as installed, cost about eight times as much. However, in terms of sweeping miles, polypropylene bristles **(To page 183)**

Photo, Hercules Powder Co.



FILLING a mechanical sweeper core at Suburban Sweeper Service Inc. Bristles are supplied in 2-ft. lengths. The filling machine then bends them in half by means of a cable (at center), which acts to seat the bristles firmly in the core grooves. Final length of bristles is about 12 inches. Sweeper using PP bristles proved effective in snow-cleaning operations (below) at Picatinny Arsenal, N. J. Since filaments are oriented as they are extruded, cold weather does not constitute a problem. Bristles hurl debris a considerable distance, so use on city streets is dangerous.

Photo, Enjay Chemical Co.

LET'S NOT PRICE OURSELVES

As each new plastic is introduced to the pipe industry—particularly the tough new plastics that can meet working demands in thinner wall sections—the cost-cutting claims that fill the air would lead one to conclude that each represents the final panacea for the entire industry. High-density polyethylene, as just one example, came rushing into the market with such claims as ". . . it is more economical for an extruder to make pipe meeting commercial standards from NSF approved high-density material than from either low- or medium-density polyethylene resins."

While, on the surface, these statements seem to hold much truth, in actual practice the pricing policies of most pipe extruders have thus far prevented them from actually turning these principles into a profit.

The simple fact is that pipe extruders have been pricing the finished pipe on the basis of the cost/lb. of the raw material; and, consequently, negating to their disadvantage the fact that they are not selling the finished pipe by the pound—but by the foot!

While a relatively small percentage of the readers of MODERN PLASTICS are in the pipe extrusion business, the conditions set forth in Dr. Abramowitz's article hold for other areas of proprietary production—and even custom molding.

Melamine dinnerware, polyethylene trash cans, blown bottles, high-pressure laminates, and some foams have, in the past year, been subject to pricing policies that could only lead to loss.

Your editors submit that this subject is of vital interest and will welcome correspondence germane to the matter.

High-density vs. low-density PE

When high-density polyethylene first made its appearance, extruders found that the toughness of the new material gave them an opportunity to reduce pipe wall thickness—and, consequently, weight of the finished pipe—while still meeting commercial standards. Specific cost figures are shown in Table I, extreme right.

Armed with these figures, it seemed logical that the plastic pipe manufacturer would be able to produce a high-quality product while materially improving his financial situation. This, unfortunately, was not to be the case.

The first thing that happened was the prices *per 100 ft. of pipe* were set so that the extruder would get a *return per lb. of material* that would either be equal to or slightly greater than that which he had received when using low-density polyethylene resins, as shown in Table II.

At this stage of the game, it is obvious that the customer buying pipe by the foot now has a qualified NSF commercial standard pipe at a much lower price. As Table II indicates, this price reduction can run as high as 41.5 percent.

It now seems as if everyone gains but the extruder. And here's why: He has set his price schedule up to allow for the same dollar return per lb. of high-density PE resin (despite its higher cost to him), but seems to have forgotten that he has to process almost twice as much resin into pipe, and sell all his pipe, in order to gross as much money as when using low-density resins.

Putting the problem into more specific terms, let us assume that we sell 1 million ft. of 1-in. pipe, which includes normal growth of the business. Taking the net price per 100 ft. from Table II, we can arrive at a gross sales figure for both low-density and high-density material. Now let's apply to this the cost of Type I material at 29.5¢/lb. (according to Table II, 187,000 lb. of material goes into 1 million ft. of pipe of this type), and the cost of Type 3 material at 36¢/lb. (as in Table II, 106,000 lb. of material goes into 1 million ft. of pipe of this type). This gives us the following breakdown.

	Low-density	*High-density*
Gross sales	$130,300	$76,300
Raw material cost	55,165	38,160
Gross profit	75,135	38,140

Unless manufacturing, sales, administrative, and research expenses have been *materially* reduced, the extruder now has $36,995 less for expenses, a decrease of 49.5% in gross profit.

It may be argued in rebuttal that a major reduction in price as has resulted from the use of high-density polyethylene would spur pipe sales over and above the normal growth of the industry and the company involved. In this case, however, it would have to result in an additional

*Vice President-Manufacturing, Carlon Products Corp., Aurora, Ohio.

INTO THE RED

By Irving Abramowitz*

increase in sales of about 1 million ft., or 100%, just for the extruder to catch up with himself!

Taking all into consideration, was this drastic drop in price really necessary? The change in raw material costs could and should have resulted in a reduction in price without materially affecting the financial picture of the extruder. To arrive at the same gross revenue position of $75,135 with a cost in raw material of $38,160 would mean gross sales of $113,295. For sales of 1 million ft., this means that the price per 100 ft. in high-density PE could have been $11.33, as compared to $13.03 for low-density PE—a reduction of 13% to the customer, but without any loss to the extruder. By setting the price of high-density pipe at $7.63/100 ft., extruders are giving distributors an extra $5.40 per 100 feet. And while this is good for distributors, a few extruders can afford to give $3.70 (the difference between $5.40 and the $1.70 the distributor would make by the more realistic pricing of $11.33/100 ft.) for every 100 ft. they sell.

The case of ABS and PVC

When ABS II was originally introduced in June 1958, raw material prices were identical to ABS I materials. As can be seen from Tables III and IV, p. 154, the change-over to the tough, new ABS II materials resulted in the more ideal situation, a reduction in price to the distributors and an increased return to the extruder.

At this stage of the game, the competitive nature of the pipe industry came into play. At present, the plastics pipe manufacturers are engaged in controversy of ABS vs. PVC. As PVC gains in importance and popularity, the extruders have started to re-evaluate the economics of each of the materials. This fact has already been recognized by the resin suppliers who have dropped the price of ABS I 10¢/lb., followed by a drop in price of PVC I of 1.5¢/lb. and of PVC II of 2¢/pound. Since this article was written, however, further drops in the price of ABS have been issued.

What has been the result? Refer to Table V, p. 154, for a breakdown of the market. Section A covers some of the economies of ABS and PVC presented at a recent regional meeting of S.P.I. pipe extruders. This indicates that the use of ABS II at 1800 fiber stress was the most profitable to make and promote. But the same pitfalls that beset the industry in PE are coming into play. The customer buys feet, not pounds; and, with extruders pricing their **(To page 154)**

Table I: Comparisons of 75-lb. pressure-rated pipe meeting Commercial Standard 197-60

	Weight (lb./100 ft.)			Resin cost ($/100 ft.)		
Size	Type I	Type II	Type III	Type I[a]	Type II[b]	Type III[c]
¾	11.4	7.6	6.9	3.36	2.47	2.48
1	18.6	13.4	10.6	5.49	4.35	3.82
1¼	32.5	23.0	19.0	9.59	7.47	6.84
1½	45.0	31.6	25.6	13.27	10.27	9.22

[a]ASTM Type I: 0.910 to 0.925 g./cm.³ base resin density. Pipe made of low-density PE meeting the S.P.I. design hoop stress rating of 285 p.s.i. Price of NSF approved resin $0.295/lb. [b]ASTM Type II: 0.926 to 0.940 g./cm.³ base resin density. Pipe made of medium-density PE meeting the S.P.I. design hoop stress rating of 510 p.s.i. Price of NSF approved resin $0.325/lb. [c]ASTM Type III: 0.941 to 0.965 g./cm.³ base resin density. Pipe made of material meeting the S.P.I. hoop stress rating of 600 p.s.i. Price of NSF approved material $0.36/lb.

Table II: 75-lb. pipe, dollar return per lb. of resin

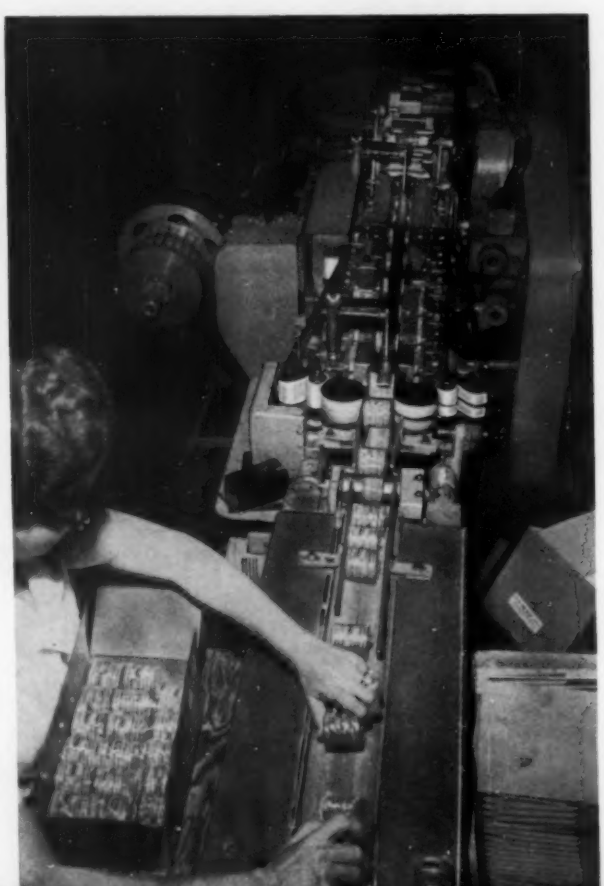
	Low-density, Type I			High-density Type III		
Size	Weight	Net price per 100	Ret./lb.	Weight	Net price per 100	Ret./lb
		$	¢		$	¢
¾	11.4	8.24	72	6.9	4.83	70
1	18.7	13.03	70	10.6	7.63	72
1¼	32.5	22.76	70	19.0	14.70	77
1½	45.0	31.40	70	25.6	20.02	78

Fluorocarbon

Got a sticky problem? Then perhaps fluorocarbon plastics are the answer to your materials-handling predicaments. How? Take a look at what these plastic materials have done for the Tom Huston Peanut Co., Columbus, Ga., in sending their "gooey" confections smoothly down the production line.

The confectionery company will not make available any figures on just how much it has saved by turning to fluorocarbon materials (in this case, Teflon) for components of mixing and wrapping equipment and for work surfaces. However, it does admit that the switch has completely revolutionized its manufacturing operation and resulted in sizable savings.—**End**

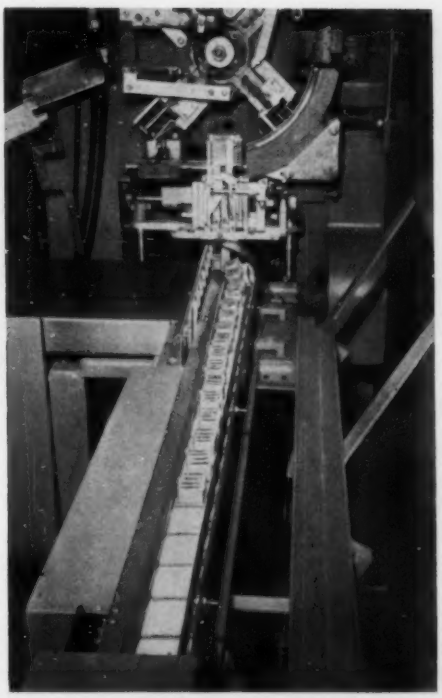
TUBING: Cylindrical extrusions of fluorocarbon plastics, slipped on round core, result in superior hooks required for pulling taffy. With this construction, one quick pull and the taffy slides readily off the almost frictionless hook. Prior to use of fluorocarbon sleeving, residue remaining on hooks constituted a troublesome cleaning problem, involving considerable down time. Tubing, supplied by regular distributors, is fabricated on the job. Photos, Du Pont



COATED FABRICS: Spray coating of fluorocarbon resin on glass fabric-covered table (top) makes it easy to whip taffy around after it has been pulled. Not only does the coating reduce cleanup time considerably, but it also makes possible substantial savings in flour and taffy material that was previously wasted. The machine at right, used in sealing cellophane-wrapped peanut butter sandwiches, incorporates guide rolls and endless belts using fluorocarbon resin. The guide rolls are fabricated from tube stock; the belts are coated glass fabrics. Before redesign, the cellophane wrapping often melted or stuck when it got too hot in sealing. The machine is a sandwich spreader and wrapper made by Lynch Corp.

handles a sticky problem

FABRICATED SHAPES: Chocolate candy bars have contact only with parts fabricated from stock fluorocarbon shapes. Components made of this material include white guides, backstop, tuckers, and elevators.



SHEET: Individual trays fabricated from fluorocarbon sheet material prevent sticky fig bars from bottling up the packing assembly line. This operation used to involve numerous shut-downs. The problem was solved by Wright Machinery Co., which incorporated fluorocarbon conveyor pockets in the design of the machine.

EMBEDMENT: An interesting application—but one which has not yet been perfected—is the use of a solid block of fluorocarbon with embedded heating elements to replace cast iron for sealing two-color wrappings. Cast iron heat-sealers smear the ink. Fluorocarbons are said not to have this shortcoming.

HERE'S THE PROBLEM IN A NUTSHELL: It'll take a long time to get this kettle clean again. Coating it with fluorocarbon—a technique which Huston is investigating—would cut clean-up time to a fraction of what it now takes. It would also reduce appreciably the time it now takes to scrape out candy mixtures.

For acrylic sheet, two novel uses:

GEODESIC DOME AND

BOTANICAL GARDEN is enclosed by geodesic dome that is comprised entirely of skin formed of rigid acrylic panels.

While one swallow doesn't make a summer, nor one application a breakthrough, the acrylic-glazed structure illustrated on these pages may well be the forerunner of new building concepts involving extensive use of methacrylate sheet. In this case, use was about as extensive as it could get—100 percent.

The building, one of the world's largest greenhouses, stands in the Missouri Botanical Garden, St. Louis. Measuring 70 ft. high and 175 ft. across at the base, it is said to be the first geodesic dome with a rigid transparent skin. It also incorporates an all-acrylic, underwater tunnel.

Initially, the roof design called for a skin of flexible, transparent plastic film to be suspended—tent-like—over a metal framework. However, according to the architect, no film could be found that could be expected to endure for more than several years under the buffeting of the elements. Not only would it have to be replaced regularly, but also its failure might also endanger plants (some of them extremely rare and exotic) kept in the "greenhouse." It was then decided to go to to a rigid skin. Glass was the first candidate considered; it was eliminated on two counts: 1) the danger to visitors should it be broken in a hail storm, and 2) the resultant weight, which would require a costlier framework. Methacrylate sheet was selected because of its transparency, rigidity, light weight, and weather resistance.

A total of 3943 individual pieces of 3/16-in. methacrylate sheet were used in making the roof. Panels are basically triangular and average about 10 sq. ft. in area. Altogether, 55 different sizes are needed to accommodate the various angles formed by the geodesic framework.

The panels are routed to size to a tolerance of ±1/64 inch. In order to assure this precision, the

UNDERWATER TUNNEL

templets used are also made of methacrylate. In this way differences in dimensions due to thermal expansion or contraction of sheets during processing are nullified. Three pieces were cut at one time, using a 2-hp. Stanley router with a carbide cutter. During routing the three sheets and the templet are held in an air clamp. The corner of each triangle is cut in a concave curve to fit over the tubing of the supporting frame.

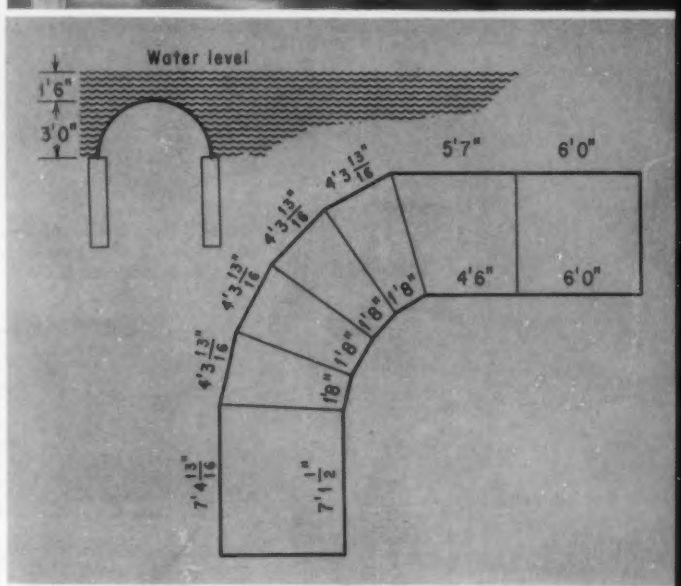
The panels are supported and linked with a triangular network of extruded aluminum mullions hung from the main dome structure. A self-locking neoprene gasket grips the acrylic sheets and seals the joints.

Although the suspended skin has no structural function, it must be capable of withstanding snow and wind loads. Consequently, among the requirements to be met by the sheet was the ability to sustain live loads of 35 to 40 lb./sq. foot. According to tests reported by Synergetics Inc., Raleigh, N. C., engineers for the structure, the exterior side of panels are loaded to 75 lb./sq. foot. Panels bellied inwards, but sustained this load for a continuous period of one week. Upon removal of the load, there was no permanent deformation of the panels. The interior side of test panels was subjected to 35 lb./sq. ft. load with similar success.

Transparent underwater tunnel

An interesting use is made of formed acrylic sheet in building the tunnel under the water plant exhibit. The tunnel is completely surrounded by water and permits visitors to view aquatic flora at levels normally not available to spectators. The topmost part of the tunnel is about 1½ ft. below the surface of the water. In this case, it is necessary for the methacrylate sheets to carry the entire load of the water.

Clear sheet, ½ in. thick, is cut as shown on the accompanying diagram. Sections are then formed to 3-ft. diameters and are mounted and joined with a system of ¼-in. aluminum extrusions and set in a Neoprene cushion caulked with Thiokol (Thiokol Chemical Corp.). Seven sections are involved in this unique application. They were formed by Texstar Plastics, Ft. Worth, Texas, and furnished by them to the Nurre Companies Inc., St. Louis, glazing contractors for this job. Plexiglass sheet for this application was supplied by Rohm & Haas Co., Philadelphia, Pa.—**End**



UNDERWATER TUNNEL uses acrylic panels to form transparent roof. Design affords garden visitors a fish's-eye view of many varieties of aquatic plants. Diagram shows position of tunnel in relation to water and pattern dimensions to which acrylic sheets were cut before they were formed into arched shape.

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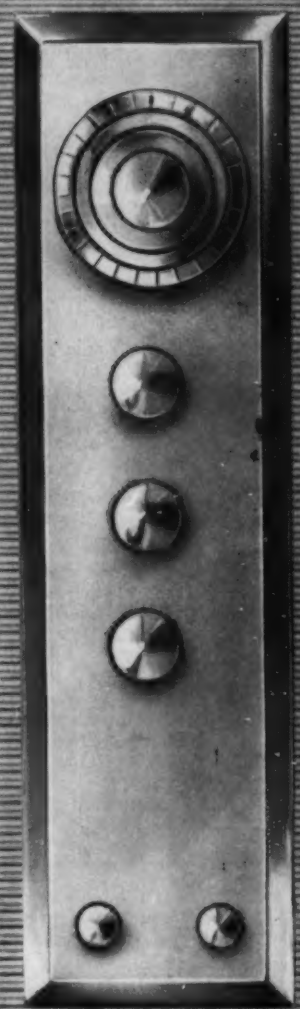

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George R. Smoluk, ENGINEERING EDITOR

PLASTICS ENGINEERING*

PROCESSING • FABRICATION • PRODUCT DESIGN • TOOL AND EQUIPMENT DESIGN

A guide to radiation equipment

What are the process factors that affect the efficiency of plastic irradiations? How do the three commonly used modes of operation compare in cost?

By John W. Olander†

Although there are several types of atomic radiation, only three types have been found to have commercial significance in the processing of plastic materials. These three are high velocity electrons, X-rays, and gamma rays. Any one of these radiations can be used to produce either one of two opposing effects in polymeric materials, depending, of course, on the polymer system that is under treatment as well as the intensity of the radiation (1).[1]

First, ionization leading to the destruction of chemical bonds within the polymer molecule can occur, and this gives rise to the formation of radical fragments which in turn can recombine to form new bonds between adjacent molecular chains to cause crosslinking and further polymerization. Typical of this mechanism is the behavior of polyethylene when exposed to non-excessive amounts of radiation.

The second effect is similar to the first except that, in this case, fracture of the polymer chain takes place without any recombination of the radical molecules formed by the ionization. This results in a net depolymerization reaction at a rapid rate and produces an irradicated product with a lower overall average molecular weight than the starting material. This effect can be put to a useful purpose to depolymerize cellulose in making

*Reg. U.S. Pat. Off.
†High Voltage Engineering Corp., Burlington, Mass.
[1]Numbers in parentheses designate references at end of article, p. 197.

Definitions

Mev = 1 million electron volts, the energy equivalent to the kinetic energy acquired by an electron accelerated across a potential of 1 million volts.

Rad = 100 ergs per gram

Megarad = 1 million rads
= 10 watt-seconds per gram
= 4.5 kw.-sec./lb.

Watt = 10 million ergs per second
= 100,000 gram-rads per second
= 0.1 gram-megarads per second

Kilowatt = 795 megarad-lb./hr.

Accelerator power = Energy (mev) times average beam current (milliamperes)

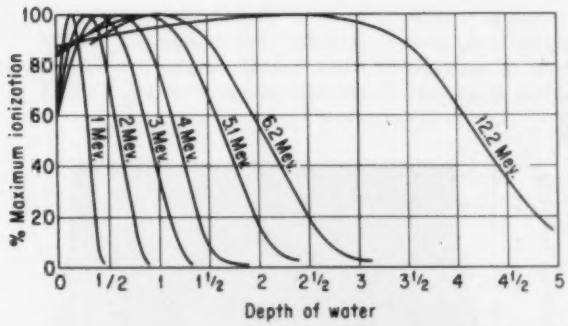


FIG. 1: Characteristic penetration curves of electronic radiation in water at several electron beam energy levels. Data after Trump and Van de Graaff; Gund and Wachsmann; Skagas, Scag, and Rogers.

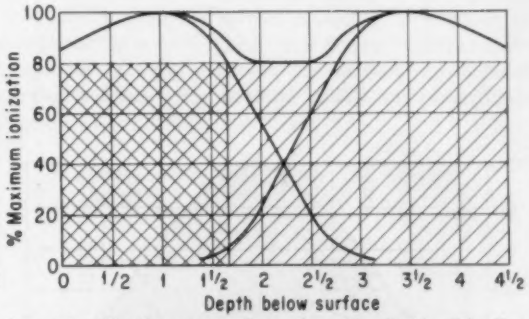

% Maximum ionization
100
80
60
40
20
0
0 1/2 1 1½ 2 2½ 3 3½ 4 4½
Depth below surface
One side effective penetration = 1.7 cm. Cross fired effective penetration = 4.5 cm.
One side depth utilization = 72% Cross fired depth utilization = 87%
Cross firing
Single beam

FIG. 2: Dosage vs. depth of penetration in water for cross-fired and single 6 Mev electron beams to yield dose uniformity in depth of 80 to 100 percent.

Table I: Promising radiation processes for high-molecular-weight chemical compounds

Process	*Reactant*	*Type*	*Dose (mrad.)*	*Status*	*Remarks*
Cross-linking	Polyolefins		> 6.0	Production	Shrinkability, improved strength, m. p., heat distortion, dielectric values. G-value increase 8×
	Polyvinylchloride	Allyl ester promoted	< 5.0	Development	
	Polyester	Curing	4.0	Development	Better control of process.
	Rubber	Curing	>10.0	Development	
	Silicones	Curing	> 2.0	Pilot plant	Better properties due to low-temp., and absence of residual accelerators
Grafting reactant with					
Polyolefins	Styrene	Total, vinylbenzene	0.4 to 3.5	Development, pilot plant or small production	Increase in tensile strength, elastic modulus, surface reactivity, temp. resistance
	Acrylonitrile	Total, vinylbenzene			
	Acrylamide	Total, vinylbenzene			
Fluorocarbons	Styrene	Surface	1.75	Small production	Can be bonded, dyed, printed
Polymethacrylates	Acrylonitrile	Total	0.5 to 1.5	Development	Reduced swelling, solvent resistant. Heat resistant
Polyvinylchloride	Acrylonitrile	Total		Development	
Rubbers	Acrylonitrile	Partial		Development	
Polyamides	Methacrylic acid	Surface, Pre-irradiated	0.5 to 1.5	Pilot plant	Reduction of static. Increased wetting, dye acceptance
Polyesters	Methacrylic acid	Surface, Pre-irradiated		Pilot plant	
Cellulose acetate	Vinyl acetate	Total		Pilot plant	Extrudable without solvent

rayon to control uniformity and molecular weight.

In addition to the intra-molecular effects on homopolymers as described above, ionizing radiation can be used to graft, or build-up, one polymer on the surface of another polymer. This is done by irradiating one polymer in contact with the monomer of interest. As an example, the irradiation of a polyethylene film while it is still immersed in styrene monomer will result in a molecular film of styrene-ethylene copolymer being deposited on the surface of the polyethylene film. Film is processed in this way to provide a surface which is more receptive to printing inks and adhesives, thus upgrading the quality of the polyethylene film. The surface can also be made more wettable and less susceptible to static build-up(2). When grafting is carried out with the surface immersed in monomer, homopolymer of the monomeric component may also form at the same time. This requires an additional processing operation to remove it. Electron radiation is sufficiently intense to minimize the percent of homopolymer formed (3).

An alternate method is to pre-irradiate the polymer, in the absence of oxygen, then expose it to the monomer immediately. This results in a graft through reaction of the monomer with the trapped free radicals in the polymer surface. A third method is pre-irradiation in the presence of oxygen. This results in a reaction between the free radicals and the oxygen to form peroxides, thus stabilizing the reactive sites. The polymer thus treated, can be stored for long periods of time in air at room temperature, then successfully grafted when heated in the presence of the desired monomer (4). Table I,

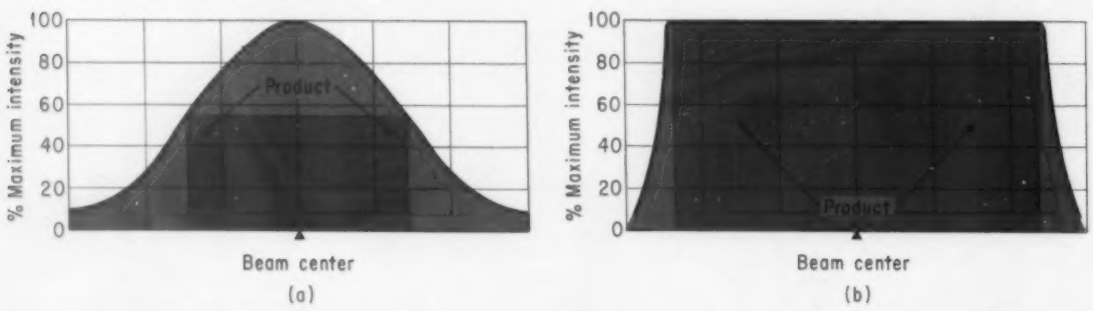
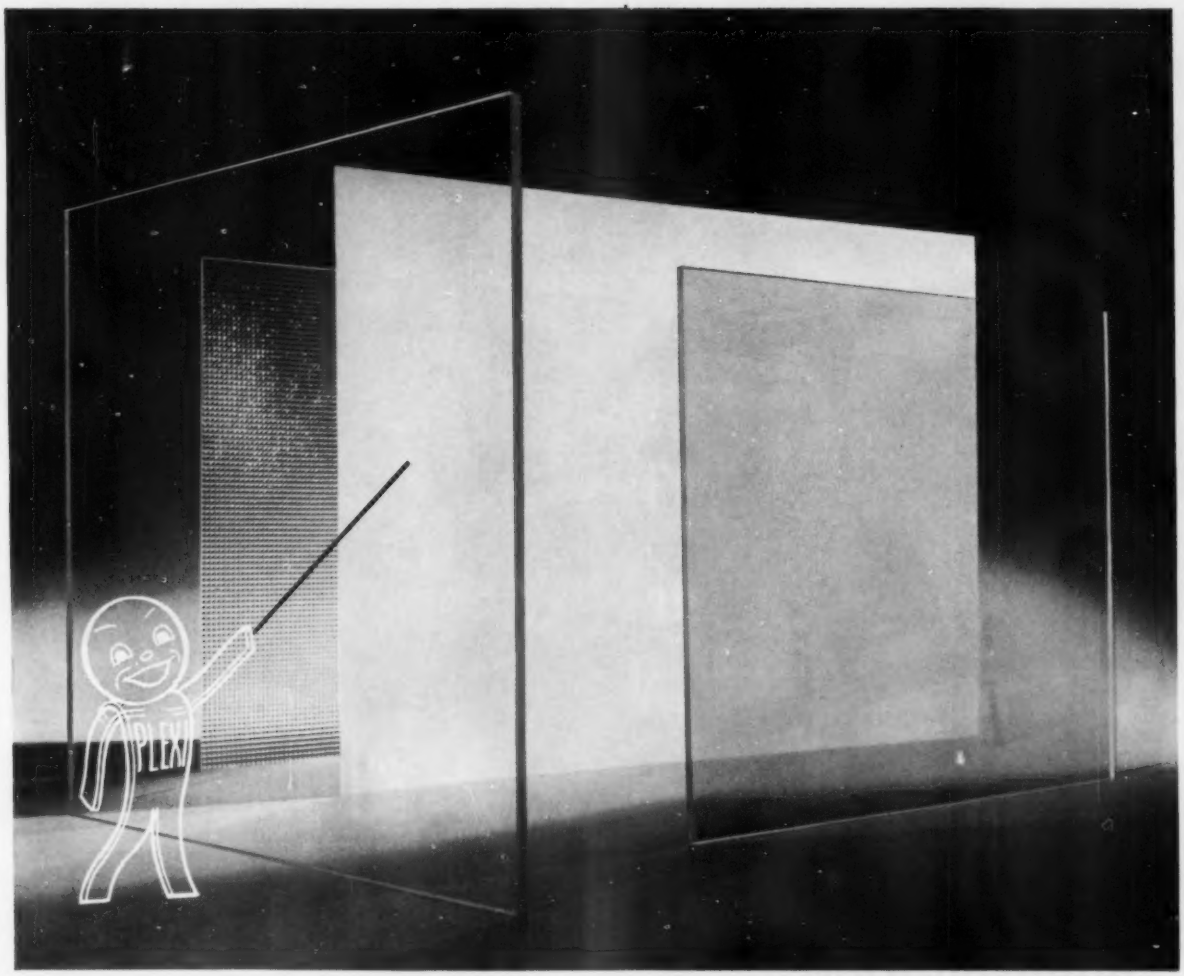


FIG. 3: Characteristic lateral distribution of beam intensity for unscanned (a) and scanned (b) electron beams.



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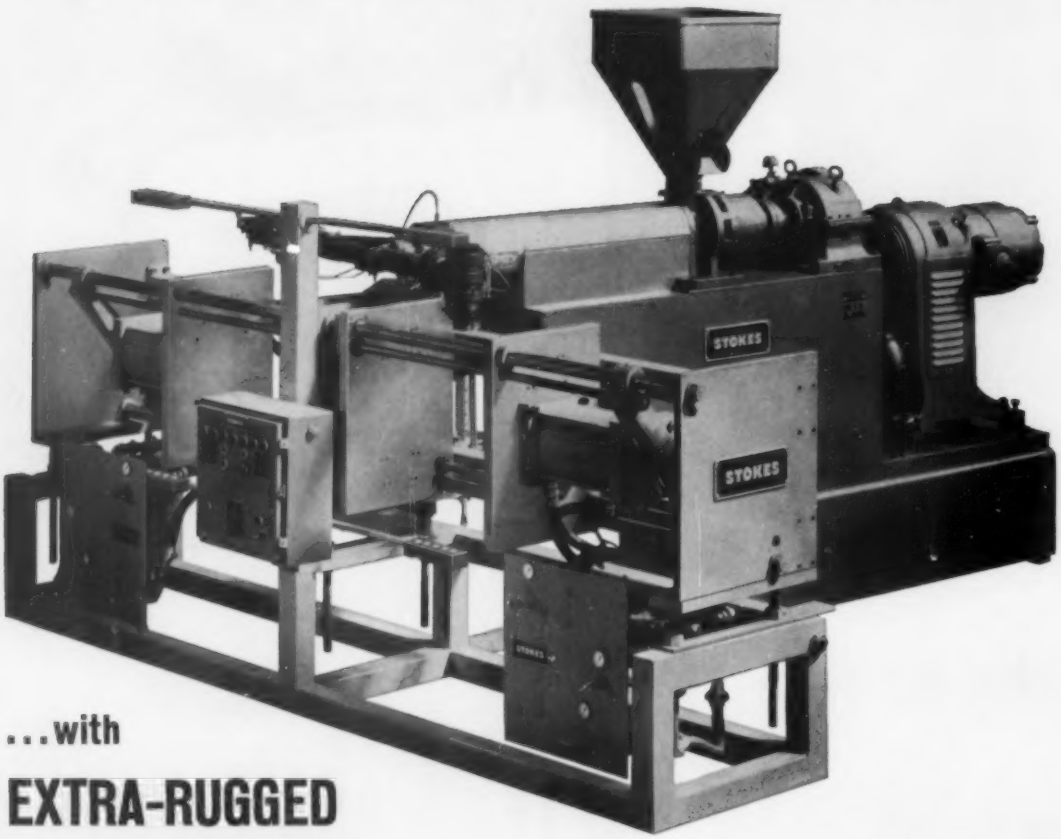

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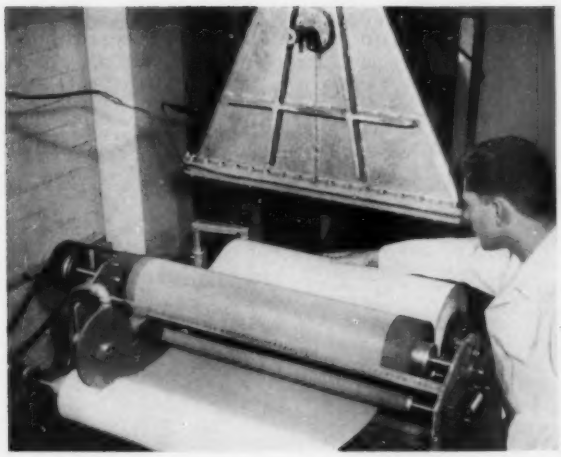

FIG. 4: Typical equipment set-up for the roll irradiation of PE film. Note that accelerator output (fan-shaped scanning gun) is mounted over roll of film.

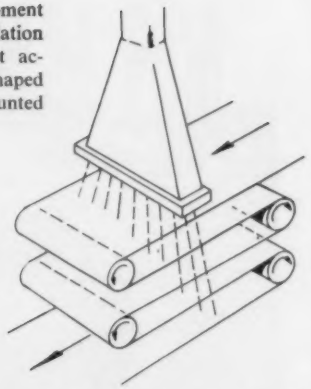

FIG. 5: Diagram showing multi-layer or multi-pass method of irradiation of the film in roll form.

p. 106, (2) is a summary of the application of radiation in the treatment and modification of plastic materials. Included in the table are the typical doses of radiation used to achieve the various effects. While every effort was made to make the table as accurate as possible, much of the current work is still a trade secret and the figures as well as the development status are best approximations.

In addition to the simple polymerization and depolymerization effects, several secondary effects also result from the radiation treatment of a plastic material. For example, in the case of polyethylene, crosslinking is accompanied by hydrogen evolution, loss of crystallinity, increased unsaturation, and oxidation (5). The net result is a change in many physical properties of the polyethylene, namely, increased temperature and solvent resistance, increased tensile strength, increased melt viscosity, decreased elongation, higher resistance to deformation under load, and improved environmental stress cracking (6).

Another physical characteristic of irradiated polyethylene film is of commercial interest. When oriented at elevated temperatures and quenched after irradiation, the film develops a "plastic memory" which renders it heat shrinkable. About 2,000,000 lb./yr. of film and tubing are being made in this manner. The product is excellent for food packaging, encapsulation of electrical components, cable connections, and wire bundle jackets (7).

Until very recently, it has been generally accepted, that a plastic material first had to be fabricated into the finished product before it could be beneficially treated with radiation. In many cases this will still be true, depending on the radiation dose and the overall technique used to produce the irradiated part. As mentioned above, the crosslinking of the material increases its heat resistance and its melt viscosity, which makes it more difficult to process using conventional injection or extrusion techniques. Because the product had to be fabricated prior to irradiation, the efficiency of radiation often suffered because of oddly shaped product configurations; power absorption efficiencies often ran as low as 5% or less.

Within the past few months a process has been developed where-

Table II: Range of beam energies and wire sizes for double bombardment

Energy	*Insulation wall*	*Conductor sizes*
	in.	
40 to 75 Kev	0.025	0.026 to 0.096 in. or 22 to 11 gage (AWG)
150 to 300 Kev	0.050	0.050 to 0.190 or 16 to 5
0.75 to 1 Mev	0.100	0.160 to 0.300 or 6 to 1
1.5 to 2 Mev	0.150	0.180 to 0.340 or 5 to 0
3 to 3.5 Mev	0.200	0.320 to 0.440 or 0 to 000

Note: Energy is a strong function of both wall thickness and conductor size. Each range covers a group of insulated wires over the ratios of wall thickness to conductor size from about 1:1 to about 1:3.

Table III: Rate of production of irradiated material in pounds per hour per kilowatt of electron beam power output for various levels of dose and electron beam absorption efficiency

	Dose, megarads								
Efficiency	0.01	0.1	1	2	10	15	20	50	100
%									
100	80000	8000	800	400	80	53.3	40	16	8
90	72000	7200	720	360	72	48	36	14.3	7.2
80	64000	6400	640	320	64	42.6	32	12.8	6.4
70	56000	5600	560	280	56	37.3	28	11.2	5.6
60	48000	4800	480	240	48	32	24	9.7	4.8
50	40000	4000	400	200	40	26.6	20	8.0	4.0
40	32000	3200	320	160	32	21.4	16	6.4	3.2
30	24000	2400	240	120	24	16	12	4.8	2.4
20	16000	1600	160	80	16	10.7	8	3.2	1.6
10	8000	800	80	40	8	5.3	4	1.5	0.8

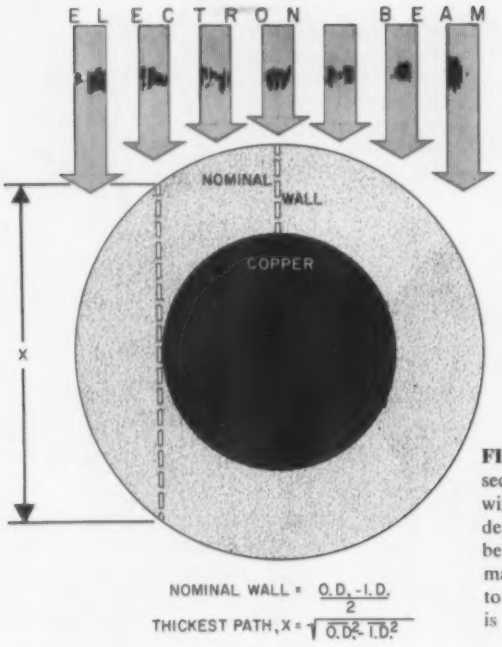

FIG. 6: Schematic cross-section of plastic-coated wire, showing maximum depth of insulation (x) to be considered when estimating the dose that is to be used when the wire is not rotated.

Table IV: Production rates of various combinations of web widths and thicknesses of polyethylene film in feet per minute per kilowatt of electron beam power output. Dose delivered at all rates shown is 1 megarad

Width of sheet	*Thickness, mils*				
in.	*2*	*10*	*50*	*100*	*125*
5	3000	600	120	60	48
10	1500	300	60	30	24
15	1000	200	40	20	16
20	750	150	30	15	12
25	600	120	24	12	9.6
30	500	100	20	10	8
40	375	75	15	7.5	6

in polyethylene powder or pellets are irradiated prior to fabrication. Treatment of the plastic in powder form permits radiation absorption efficiencies in excess of 75% because the powder can be handled in such a fashion as to obtain optimum utilization of the radiation beam. The treated powder can then be formed into products with qualities highly competitive to Teflon. Because of the increase in radiation efficiency, the parts made from irradiated polyethylene can now be made at lower cost.

Dose and dose rate

As is shown in the box on p. 105, dose, in rads, is the total amount of radiation energy provided per unit mass of the material being irradiated. The dose of radiation required for various treatments of plastics will vary widely, depending on the polymeric system under consideration (see Table I). Since the input power required to deliver a dose varies directly with the amount of the dose, those processes requiring large doses will require more power and be more costly. In some cases it is possible to reduce the power required to achieve a given result by using additives in the material to be treated. Acting somewhat like a catalyst, the additives are not necessarily affected by the radiation themselves, but promote some of the reactions which are produced by the radiation treatment. This allows the use of a smaller dose, hence a lower power consumption, and can produce the desired radiation modification at a lower cost. For example, when irradiating polyvinyl chloride, the addition of a small amount of tetrafunctional monomer drastically reduces the radiation dose that is required for crosslinking and it also serves to preserve the heat stability of the crosslinked polyvinyl chloride product (8).

In some radiation processes, a factor equally as important as the dose, or the total amount of energy which is applied, is the rate at which the energy is applied—the dose rate. Dose rate is an important consideration in free radical and graft polymerization, and similar chain reaction processes, in determining the net result produced by the radiation treatment. In general it can be said that the increase in the rate of irradiated product formation in a free radical reaction is proportional to the square root of the increase of the radiation dose rate.

Dose rate is dependent on the character of the radiation source. Gamma-ray sources and X-ray generators produce very low dose rates. Electron accelerators, particularly those with pulsed beams, produce extremely high intensities and dose rates. Various means of beam diffusion and scanning can be used with accelerators to reduce peak intensities, without reducing total power. This is desirable for those chain polymerization reactions that are more effective at the lower dose rates.

Dose rate is also an important consideration where the amount of time to which the product can be exposed to radiation is limited, *i.e.*, in some processes for the irradia-

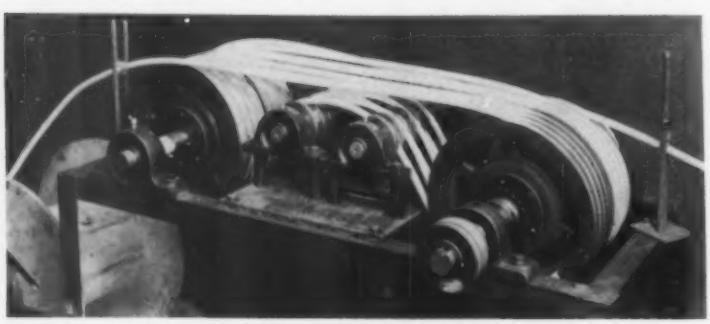

FIG. 7: Picture shows wire guiding equipment for the irradiation-treatment of coated wire. Multiple passes are used to maximize utilization of the electron beam.

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Specific Gravity	1.76	1.80	1.87	1.95
Izod Impact, Ft. Lbs./In. Notch	14.4	16.2	17.3	16.5
Tensile Strength, psi	20,300	21,300	20,100	19,300
% Elongation	1.89	1.92	1.94	1.87
Modulus of Elasticity in Tension, psi x 10^6	1.15	1.36	1.45	1.85
Flexural Strength, psi	33,150	33,600	37,800	37,000
Modulus of Elasticity in Flexure, psi x 10^6	1.08	1.18	1.44	1.20
Barcol Hardness (10 Sec. Reading)	55	57	62	66
Initial Viscosity of Mix	1,200	2,100	3,200	5,000
Glass Mat, % by Weight	40	40	33.3	33.3

Diamond Chemicals

tion of plastic film where the film exposure is related to desired production linear web speed. If a plastic film is being treated at *x* ft./min. using a specific dose rate corresponding to a beam power of 1 kw., and it is desired to process the film at 2x ft./min., the dose rate, and, consequently, accelerator power must be increased by the same factor of 2 to maintain the same radiation dose. It can be seen that the dose rate must vary inversely with the time of exposure for a given dose.

Electron beam penetration

A beam of electrons loses energy as it travels through a material. Ultimately it expends all its energy, and its ability to cause ionization, and is absorbed by the material. The penetrating ability of an electron beam at all energy levels varies in direct proportion to its initial energy content and in inverse proportion to the density of the material being irradiated. For a given beam energy the range may be expressed in terms of the weight of material to be irradiated per unit of its exposed area, which takes into account both density and thickness. Thus, penetration is frequently expressed in g./sq. cm., which is found by taking the product of the material thickness in cm. and the material density in g./cu. centimeters. For water or other unity-specific gravity materials, the thickness in centimeters is equivalent to the g./sq. cm. value. It is now common practice to express the penetration thickness as "the equivalent thickness at unity specific gravity" (or equivalent thickness of water). For example, the energy absorbed from a beam of electrons with a given power at a depth of 1.36 cm. in PE with a density of 0.92 g./cu. cm. is equivalent to the energy absorbed from the same electron beam at a depth of 1.25 cm. in water (1.36 × 0.92).

Figure 1, p. 105, shows the effect of increasing the energy of the electron beam on the beam's ability to penetrate water. Referring to Fig. 1, a beam with an energy of 1 Mev has completely expended its ionizing ability, or radiation effectiveness, after passing through less than 0.5 cm. of water, whereas a beam with an energy of 12.2 Mev will penetrate over 4.5 cm. of water before expending its radiation effectiveness. Dividing the above depths of penetration by the density of polyethylene will give the depths of penetration of the above beams in polyethylene.

While the total power of the beam would be expended in passing through the thicknesses above, Fig. 1 also shows that the effective ionization, or dose, delivered by the beam to the material is not uniform at all depths along the path of the beam. The curves shown are profiles of the ionization occurring throughout the path of the beam in the material. Using the 4-Mev curve in Fig. 1, maximum ionization produced by a beam of this power entering **(To page 116)**

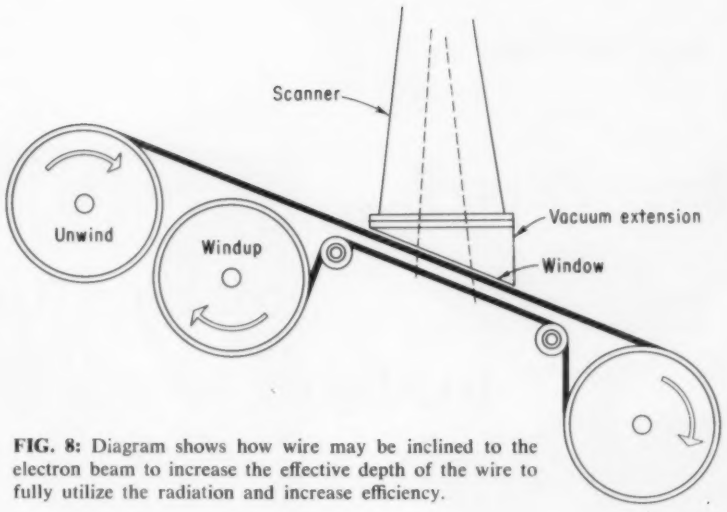


FIG. 8: Diagram shows how wire may be inclined to the electron beam to increase the effective depth of the wire to fully utilize the radiation and increase efficiency.

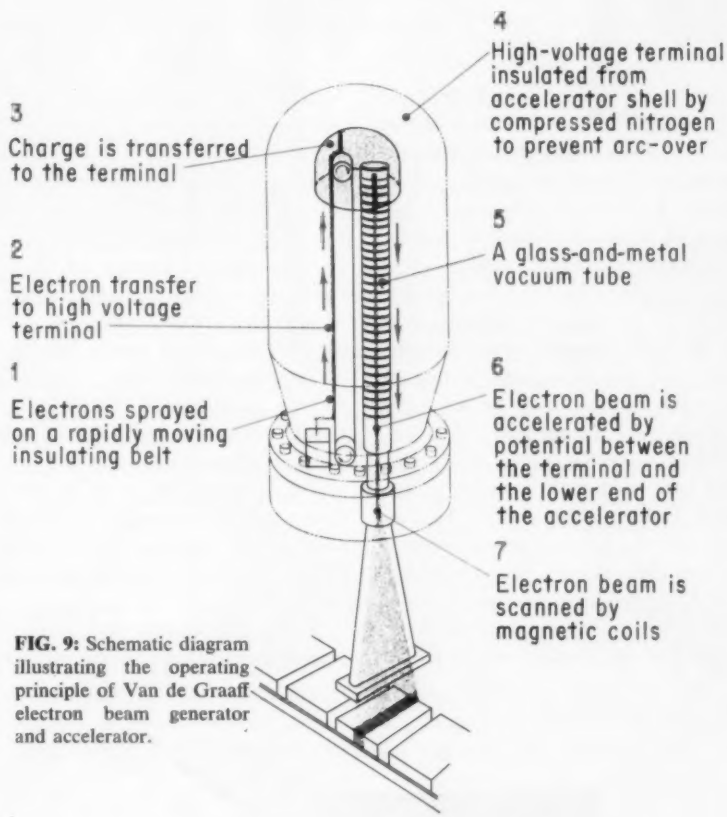

4
High-voltage terminal insulated from accelerator shell by compressed nitrogen to prevent arc-over
3
Charge is transferred to the terminal
5
A glass-and-metal vacuum tube
2
Electron transfer to high voltage terminal
6
Electron beam is accelerated by potential between the terminal and the lower end of the accelerator
1
Electrons sprayed on a rapidly moving insulating belt
7
Electron beam is scanned by magnetic coils

FIG. 9: Schematic diagram illustrating the operating principle of Van de Graaff electron beam generator and accelerator.

At Eastman you can find plastics to shape a new world of products

Ideally suited to modern high-speed vacuum-forming techniques, Tenite plastics are cutting costs sharply for many manufacturers

Vacuum forming—one of the oldest techniques of fabricating plastics, but only in recent years adapted to speedy modern methods—is now in the foreground of interest as an important method of shaping plastics products for today's market.

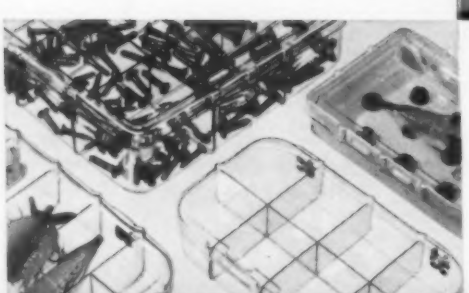
Starting material for a vacuum-forming operation is an extruded thermoplastic sheet. In simplest terms, vacuum forming involves only two steps, both performed on the same machine. The first step consists of clamping the flat sheet of plastic in a frame above the waiting mold and heating it (with built-in heaters) to the required forming temperature. In the second step, the heated sheet is brought down into close contact with the mold, suction is applied, and atmospheric pressure then forces the heat-softened sheet over and into the contours of the mold.

Sheet extruded from any of the Tenite plastics is well-suited to vacuum forming. Typical commercial products made of these plastics are shown on these pages. They illustrate the diverse shapes and uses to which vacuum forming can be adapted. An outstanding advantage of the Tenite cellulosics—Tenite Butyrate, Tenite Propionate and Tenite Acetate—is their low specific heat which speeds both heating and cooling. Sheet of these plastics can be formed quickly and economically into tough, lightweight, highly impact-resistant products of enduring luster.

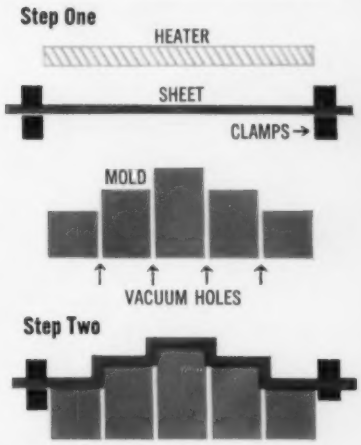
For products that are to be used outdoors, special formulations of Tenite Butyrate are available which provide excellent weather resistance and dimensional stability.

Tenite Polyethylene and Tenite Polypropylene are other Eastman plastics useful in vacuum forming. While slower to heat and cool than sheet of the cellulosics, these can be more satisfactorily formed in molds with sharp angles and offer many physical and chemical properties useful in housewares, industrial products, toys and packaging.

All Tenite plastics are available in a virtually unlimited range of colors. Over the years, the Tenite Color Laboratory has developed formulations in almost 43,000 different colors and color effects. For many applications, colored sheet can be used to yield an integrally colored product, eliminating the need for a separate decorating or painting operation. In other applica-



HOW VACUUM FORMING WORKS



NOTE: The above diagrams depict a simple vacuum-forming operation. There are many variations of this method, including some in which air pressure or mechanical pressure replaces the use of a vacuum.

tions, such as signs, clear-transparent sheet may be used, with the decoration being applied either before forming (by use of distortion printing) or after forming. It should be noted that even shapes which at first appear impossible to vacuum form can be produced by this method. For example, by using a "plug-assist" (to permit a deep draw), wastebaskets 8½" in diameter and 11½" deep have been vacuum formed from sheet of Tenite Butyrate. Similarly, spherical globes for toys and outdoor lanterns have been produced at low cost by vacuum forming two hemispheres and then solvent-cementing them together.

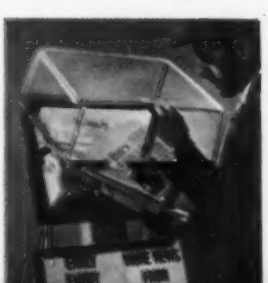
An important advantage of vacuum forming is the low cost of the necessary molds... often only 1/20th to 1/10th as much as those for injection molding. As a matter of fact, very inexpensive molds can be cast from plaster or tooled from hardwood or pressed wood to use on test runs, developmental designs, or single or short-run production.

The obvious economies inherent in vacuum forming have helped the technique win quick favor in many fields. In the manufacture of outdoor signs, displays, toys, housewares, decorative and lighting panels, vacuum forming is now a leading production method.

Vacuum forming also makes possible the rapid packaging of merchandise in bubble, blister or skin packs. Here, short heating and cooling cycles are particularly important because of the high speeds at which the packaging machines operate.

Perhaps vacuum forming with Tenite plastics could help you cut costs or speed production of some item you are now making or planning to make in the future. We'll be glad to help you explore its advantages and evaluate its merit.

The comprehensive story of how Tenite plastics are being used in this new manufacturing process is told in a 20-page booklet, "VACUUM FORMING." For your free copy, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENN.



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Versatile plastics by Eastman

Table V: Economic comparison of various types of accelerators

Type of accelerator	*Low power modest energy*[a]	*High power low energy*[b]	*High power high energy*[c]
A. Capital costs:			
1) Accelerator	$ 55,000	$100,000	$200,000
2) Facility	20,000	20,000	30,000
Total initial cost	$ 75,000	$120,000	$230,000
Amortization per year[d]	$ 15,000	$ 24,000	$ 46,000
Capital cost per hour[e]	$ 3.75	$ 6.00	$ 11.50
B. Operating costs:			
1) Labor cost per hour	2.50	2.50	4.00
2) Utilities cost per hour	0.25	0.50	0.50
C. Maintenance costs:			
1) Tubes cost per hour	4.50[f]	5.50[g]	7.50[h]
2) Other cost per hour	3.75	3.00	7.50
D. Total cost per hour	$ 14.75	$ 17.50	$ 31.00
E. Output, megarad-lb./hr.	1400[i]	3200[j]	3200[j]
F. Cost per megarad-lb.	$ 0.011	$ 0.0055	$ 0.097

Notes: [a] Model GS Van de Graaff Accelerator; 1.5 Mev, 2.5 kw. processing polyethylene powder. [b] Type ICT, 300 kev, 8 kw., 4 accelerator tubes, processing plastic film on a roll. [c] Linear Accelerator, 10 Mev, 8 kw., processing molded disposable plastic syringes. [d] Five year write-off. [e] Operating basis: 4000 hr./yr. [f] Acceleration tube. [g] Four acceleration tubes. [h] R.F. Power tube. [i] At 70% efficiency. [j] At 50% efficiency.

water would occur at a depth of about 0.6 cm. from the surface of entry (about 0.65 cm. in 0.92-density polyethylene). At a depth of 1.25 cm. in water (1.36 cm. in polyethylene) the ionization taking place in the material would only be 40% that taking place at depths mentioned above.

Note that dosage or ionization increases to a maximum at a point about one-third through the beam's total penetration range. At a depth about two-thirds to three-quarters of the total range the relative dose is equal to that at the surface. This particular depth is significant because it is the optimum thickness of a rigid, solid material to use. It is here that the best balance is obtained between minimizing overdosage and maximizing the use efficiency of the beam's power.

Fig. 1 also shows that in processing polyethylene films 2 or 3 mils thick, even low-energy beams pass through the material easily before exhibiting the maximum energy transfer as occurring in thicker materials. It is necessary to choose an energy low enough to permit maximum absorption in the film thickness, or to arrange the film so that several thicknesses can be irradiated at one time. This will be discussed more fully later in the article.

The data shown in Fig. 1 is that for an electron beam directed at the material from one side of the sample only. When material is exposed to radiation from both sides, a technique called "double bombardment," a mirror image of the penetration curve is obtained from the other side, as is illustrated in Fig. 2, p. 105. Since the ionization produced by the radiation is additive, the net ionization profile is the sum of the curves from either side of the material. In thicker parts this produces a more uniformly treated material. The most useful product thickness for double bombardment is 2.4 times that thickness listed as optimum for radiation from one side only.

Beam utilization efficiency

For maximum power efficiency and minimum cost it is necessary that 1) the maximum possible fraction of the electron beam power be absorbed in the product, and 2) the level of radiation dose in all parts of the product be as uniform as is possible. *e.g.*, that the required minimum level of ionization be achieved throughout the material with as little over-dose or energy waste as possible. Any portion of the electron beam that does not hit the product or which passes through without being absorbed is wasted, of course. Waste, and sometimes damage, also occurs when the material receives a dose larger than necessary.

To maximize irradiation efficiency, two factors must be considered: 1) the distribution of the beam energy over the product area, and 2) the absorption of the beam as it passes through the material. The over-all beam utilization efficiency will vary as the product of these two factors.

An electron beam which is produced in an accelerator is circular in cross-section and can be as large as 1 or 2 cm. in diameter. If the beam is directed at the product surface simply by aiming a stationary beam at the center of the surface, the concentration of electrons in the beam cross section approaches a typical Gaussian dose distribution, and the maximum area efficiency is less than 50% (Fig. 3*a*, p. 106). There is little lateral distribution of the beam's power and only very narrow products, such as rotating, coated wire, can be so treated.

To maximize area efficiency the electron beam is scanned. In scanning, the electron beam (which can be deflected either magnetically or electrostatically) is swung back and forth within the accelerator vacuum tube extension, emerging through a thin slot-shaped metal window, and is "sprayed" laterally back and forth across the product. The beam is scanned at the rate of several hundred sweeps per second, so that for all practical purposes, it can be considered to be a solid fan-shaped beam of electrons with a uniform lateral intensity distribution. With rectangular plastic objects, a conservative overscan is used to insure proper doses at the edges of the part. Even with the waste involved in overscan, area efficiencies exceeding 90% are attained if the product flow is uninterrupted. The distribution of beam intensity for a scanned beam is shown in Fig. 3*b*. Scanning systems are available that will permit uniform radiation of plastic films up to 40 in. wide.

Using Figs. 1 and 2, the depth efficiency of the radiation may be obtained by graphically integrating the areas under the curves. Depth efficiency ranges from 60 to 70% for single-side irradiation and up to 80% for double bombardment.

Continuous flexible films and sheets of thickness substantially smaller than the range of the beam can be irradiated with thickness efficiencies close to 100 percent. In the irradiation of a roll of film (9),

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Surgeons call it an "Oxygenator for Regional Perfusion." It acts as the patient's lungs and heart, reroutes the blood stream to prevent diseased cells from spreading, permits isolation and medication of the cancerous area for surgery. Everything but the motor is disposable after the operation. There is no hazardous sterilizing problem.

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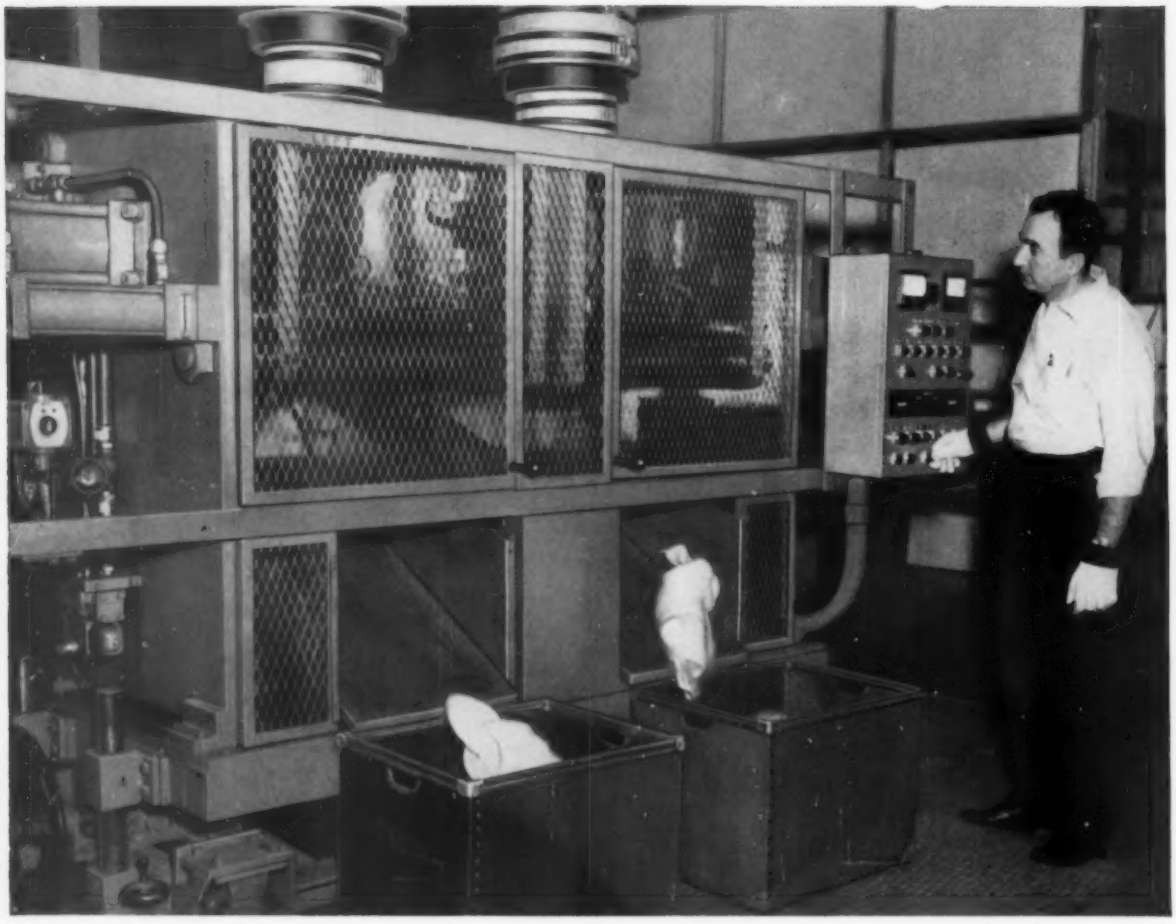
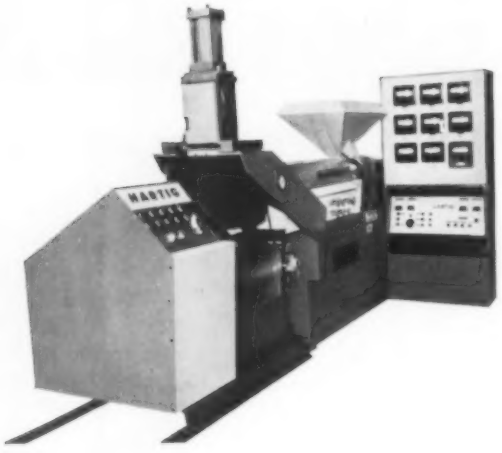


New Hartig blow molding press



in action at Ideal Toy. Shown above is one of the new Hartig blow molding machines producing doll bodies. Operation is continuous and automatic; output is of high quality and uniform; maintenance is simple. This press can handle parts up to 17-inch diameter, is track-mounted for easy mold changes and extruder maintenance.

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the film thickness is very small compared to the range of the beam and the roll thickness is much greater than the beam range. Therefore, the film is wound or unwound at constant linear web speed while the roll is irradiated. In this way the beam energy is simultaneously expended through several layers and is fully utilized. Once a small amount of initial film, or "leader," is irradiated non-uniformly in starting up, all of the remaining film will receive the same amount of total integrated dosage, until the end of the roll is reached. Fig. 4, p. 109, illustrates the equipment used.

An alternate method, equally as efficient, is a roller system (9) that passes the film under the beam in such a fashion as to present several layers of film to the beam simultaneously, thus completely absorbing the radiation in the total thickness of the several layers presented to the beam, as shown in the diagram in Fig. 5, p. 109.

The treatment of plastic objects of non-uniform thickness, such as moldings, or of varying composition, such as plastic-coated copper wire, requires a careful consideration of the specific geometry involved in order to select the best processing method. For example, the maximum thickness of a coating on wire that may be treated may be appreciably larger than the nominal wall thickness of the coating. Since the metal wire has a high density compared with that of the insulation, it is impractical to choose an energy level high enough to penetrate the entire wire because a large percentage of the radiation power will be lost in the conductor. Also, absorption of the electron beam by the wire will cast a "shadow" on the coating away from the radiation source, resulting in a non-uniform treatment of the insulation.

For the reasons above, double bombardment is the easiest way to avoid the uneven penetration problem. When selecting the proper energy level, the longest penetration path must be considered. For a wire this would be the dimension x as shown in Fig. 6, p. 110. Using double bombardment, efficiencies will vary from 20 to 40 percent. The energy levels required for various thicknesses of insulation on various wire sizes are shown in Table II, p. 109. A typical wire-guiding set-up for double-bombardment radiation of wire is shown in Fig. 7, p. 110. If a machine with fixed energy output is designed to treat a specific wire size, and at some later date it becomes necessary to run a wire of smaller size, overall efficiency can be maintained by inclining the wire to the path of the electron beam (Fig. 8, p. 113) which lengthens the beam's path through the material.

An alternate method of insuring uniformity of radiation treatment of the wire is to rotate the wire while it is being exposed. The total energy required in this method is reduced, since only the nominal thickness of the coating need be irradiated and efficiency can be increased by 50 percent. But more elaborate wire-handling equipment is required; both unwind and wind-up reels must rotate with the wire to avoid twist.

There are some applications where only the surface of the product need be irradiated to induce desired surface improvements. In these cases a low-energy electron beam of less than 100 kev is sufficient to ionize the surface layers of the material, leaving most of the volume of material unaffected.

Production capacity

In the discussions above, the energy required to produce a given dose and dose rate were considered along with methods for optimizing efficiency in the application of the dose. The next step in selecting the radiation machine is to determine the power required to keep up with the desired production rate of irradiated material.

One kilowatt of radiation power can irradiate about 795 lb./hr. of any material to a dose level of 1 megarad—if the efficiency is 100 percent. This efficiency is theoretical and, in actual practice, is never achieved. At lower levels of efficiency, and where doses larger than 1 megarad are required, the production rate of 795 lb./hr. is reduced proportionally. Production rate in lb./hr./kw. at various efficiencies and doses is shown in Table III, p. 109.

To illustrate the method of selecting the output power required for the irradiation of PE film, consider the example below.

Assume that a production rate of 500,000 lb./yr. is required and that the irradiation line will operate for 4000 hr./yr. so that an hourly production rate of 125 lb./hr. is required. The accelerator output power may be calculated in the following manner:

1. Find the dose necessary. Assume that the optimum dose has been determined by experiment to be 10 megarads.

2. Determine the efficiency which can be expected from the process technique to be used. If the multiple-layer technique (Fig. 5) is used, area efficiency (scanned beam) will be 90% and it will be assumed that a depth efficiency of 90% can be maintained. Thus net efficiency is: $90\% \times 90\% = 81$ percent.

3. Using 795 lb./hr./kw. at 1 megarad, the hourly rate per kw. is $(795)(0.81)(1/10) = 64.4$ lb./hr./kw. at a dose rate of 10 megarad.

4. Thus, the total **(To page 190)**

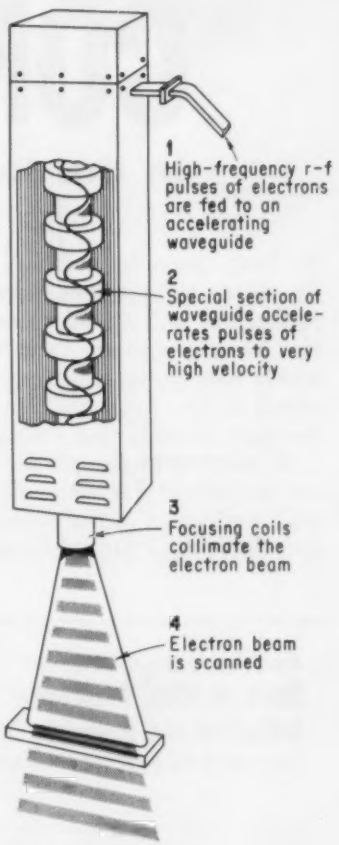
1
High-frequency r-f pulses of electrons are fed to an accelerating waveguide
2
Special section of waveguide accelerates pulses of electrons to very high velocity
3
Focusing coils collimate the electron beam
4
Electron beam is scanned

FIG. 10: Schematic diagram showing how high frequency r.f. electron beam is focused and accelerated in microwave linear accelerator.

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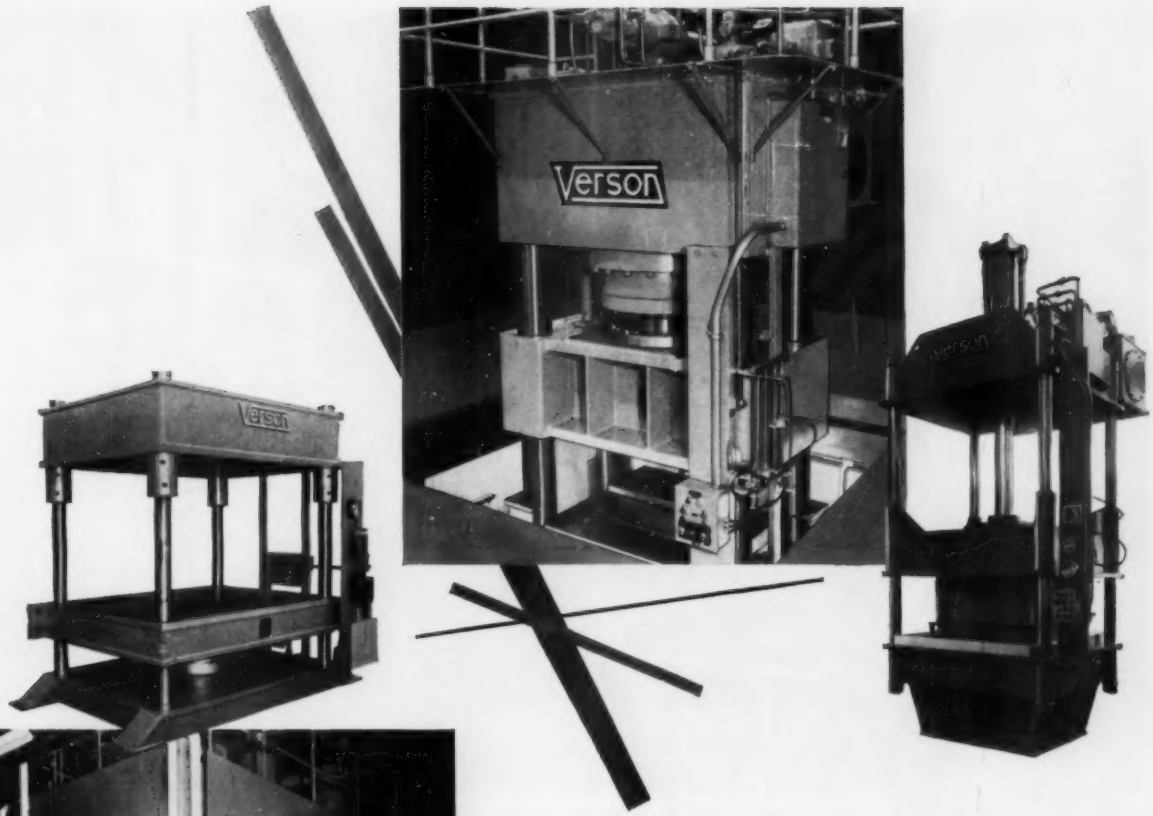

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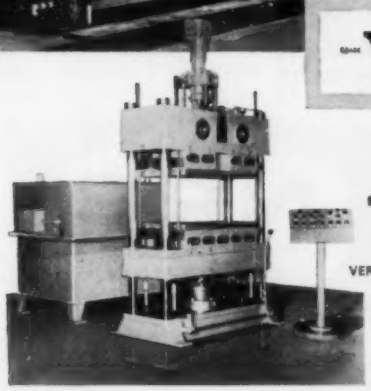

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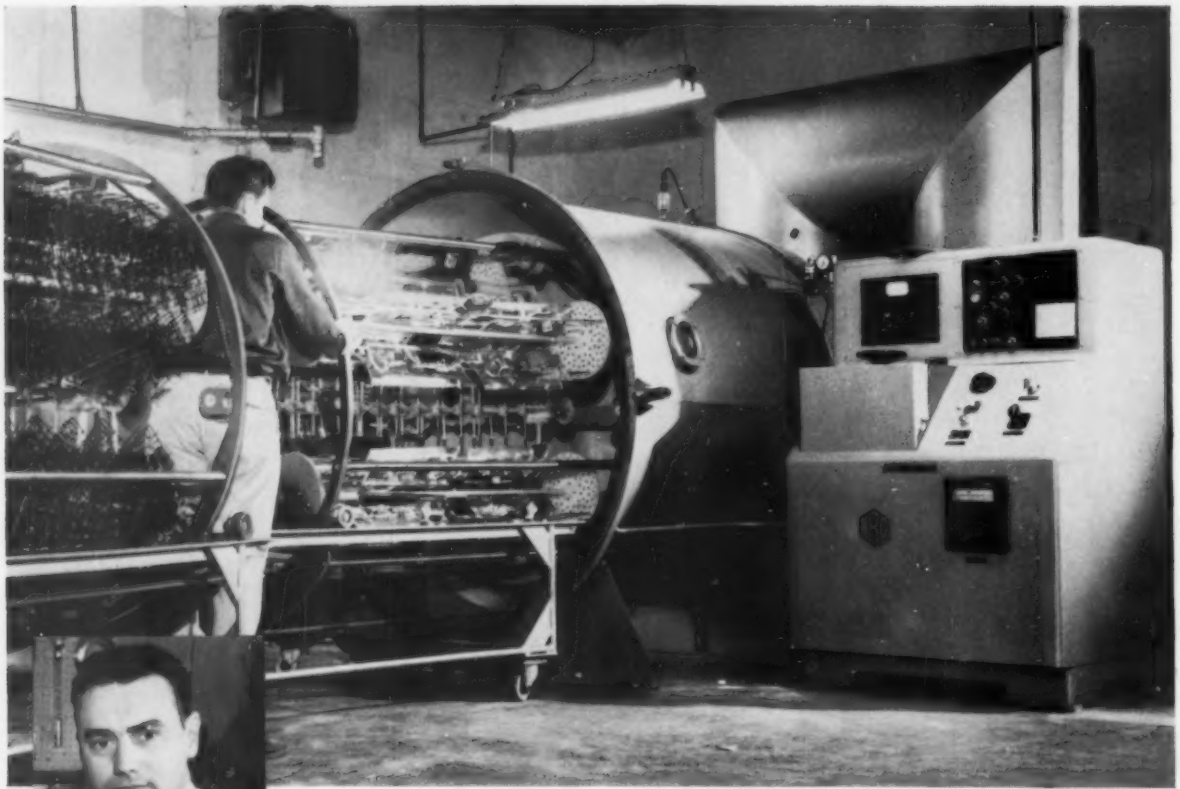

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Thermoforming techniques for high-density polyolefin sheet

By D. E. Allison* and Robert Doyle*

In an earlier article (1)[1], we discussed the design of molds which are suitable for drape forming linear or high-density polyethylene sheet. More recently, with the installation of a machine equipped with both upper and lower movable platens, we have successfully applied the same principles of mold design to several plug-, air-, and vacuum-assist techniques. In addition, we have further extended this work to include certain other high-density polyolefins. By "high-density polyolefins," we shall refer specifically here to Marlex[2] 6002 resin, a 0.960-density, 0.2-M.I., ethylene homopolymer; Marlex 5003 resin, a 0.950-density, 0.3-M.I. ethylene-butene copolymer; and closely related resins. The extrusion of polyolefin sheet from these two resins has been described elsewhere (2).

The following information thus represents a summary of our best results to date with thermoforming techniques for high-density polyolefin sheet, based on sheet which has been extruded and molds which have been designed in accordance with the authors' previous recommendations.

To help clarify some essential details of these techniques, as we employ them, diagrams have been provided. In all cases, these diagrams conform to the operation of the machine mentioned above, *i.e.*, with both the upper and lower platens movable, fixed clamps, and retractable sandwich heaters. The importance of up-to-date, versatile equipment to the achievement of optimum results will be stressed in the following sections: 1) the heating stage, which is common to all of the techniques; 2) discussions of each of seven demonstrated techniques; and 3) some factors which affect the cooling period in any of the techniques that will be discussed in this article.

Heating stage

Fig. 1, below, shows why we strongly recommend the use of sandwich heaters when forming high-density polyolefins. The data for these curves were obtained with the heaters set at 1200° F., the normal operating temperature. Each individual heater had a watt density of 2.16 kw./sq. ft., using heater rods 3-in. apart and 4-in. away from the sheet. Thus, when both the upper and lower heaters were employed to provide the sandwich effect, the total density was 4.32 kw. per square foot. A high watt density, divided between the two sides of the sheet to avoid scorching, plus a short air gap between the heaters and the sheet are two factors essential for minimum heating periods.

The advantage of sandwich heaters becomes especially evident with sheet which is over 100 mils thick. With this heavier sheet and only one heater bank (even with 3.25 kw./sq. ft. available), we find it necessary to preheat the sheet on one side and then turn it over for the remainder of the heating period. Otherwise, either the surface temperature gets too high, causing scorching or blistering, or else, with a larger air gap, the heating period is unduly long. Sandwich heaters obviate the need for this extra handling while also reducing the heating time by at least 50 percent.

Unpigmented (natural) high-density polyolefin sheet becomes "clear" to translucent over the entire forming area when it is ready to form. At the time of forming, the sheet temperature is approximately 350° F. For a given sheet thickness, the heating time for natural and colored sheet will be the same, for all practical purposes. Hence, whenever possible, natural sheet of the appropriate thickness should be used to establish the cycle. If none is available, the behavior and appearance of the blank can still be used to determine when pigmented sheet is ready to form. With a little experience this point can be judged rather closely, although it is rather difficult to define very rigorously.

However, as the sheet is heated, it will first begin to sag. With further heating, there is a tendency for the sheet to pull back up due to residual, internal stresses from the extrusion operation. At this stage, the sheet has an irregular, undulant or wavy appearance. With thicker

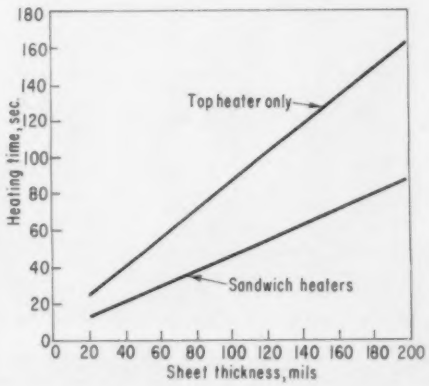

FIG. 1: Heating time vs. sheet thickness.

*Phillips Chemical Co., Sales Service Laboratory, Bartlesville, Okla.

[1]Numbers in parentheses designate references at end of article, p. 208.

[2]A trademark for Phillips' olefin polymers.

sheet, gravitational effects may exceed any internal forces and the sheet will continue to sag during the entire heating period. In either case, the sheet will go through an undulant stage followed by a gradual smoothing out with increasing sag. Just as all of the wrinkles are disappearing, high-density polyolefin sheet is ready to form. Fig. 1 may provide a guide as to when this "end point" can be expected. A slight smoking of the sheet during the heating period is not harmful. In fact, a little overheating is sometimes employed to make one surface of the part more glossy. Actually, there is a relatively wide range of temperatures within which high-density polyolefin sheet may be formed successfully.

Forming stage

Once the sheet is properly heated and softened, any one of a number of forming techniques may be employed. Seven of these are listed in the "Selection Guide" and illustrated in Figs. 2 to 8, right.

Airslip and pressure forming are not included, but we hope to report on these techniques at some later date. Free forming has not been considered because high-density

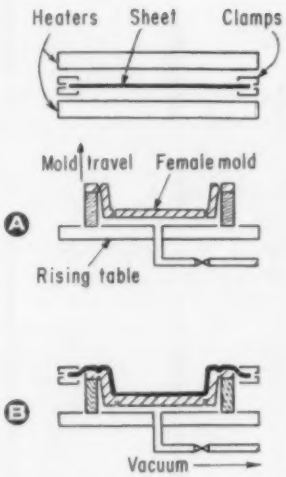

FIG. 2: FEMALE DRAPE: a) clamp and heat sheet; and b) with edges of the sheet sealed against mold, apply vacuum.

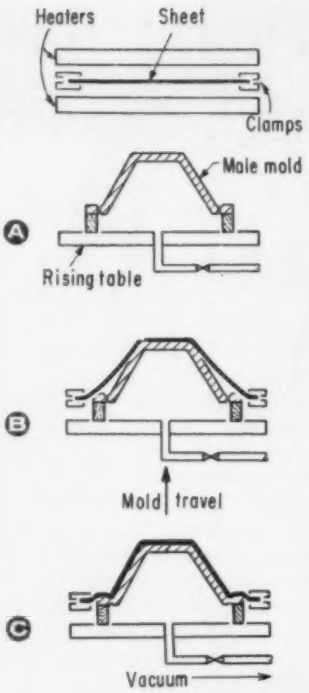

FIG. 3: MALE DRAPE: a) clamp and heat sheet; b) mold advances upward into heated sheet; c) vacuum is then applied to complete the vacuum forming operation.

Forming technique selection guide for high-density polyolefin sheet

Type of forming	Maximum draw ratio[a]	Glossy surface	Means of texturing[b]	Uniformity of walls at max. draw	Tooling required: Male mold	Tooling required: Female mold	Tooling required: Plug	Tooling required: Vacuum box	Equipment required[c]: Lower platen	Equipment required[c]: Upper platen	Comments
Female drape	0.7:1	Inside	Mold	Fair		●			●		Only for shallower, simpler items. Permits closest spacing of multiple molds.
Male drape	1:1	Outside	Sheet	Fair to good	●				●		Only for smaller, simpler items. Somewhat less thinning than with female molds.
Inverted male drape	1:1	Outside	Sheet	Good	●					●	For large-area male molds where sag might be a problem.
Plug-assist	1:1	Inside	Mold	Excellent		●	●		●	●	Best for most tote boxes and similar products.
Vacuum snap-back	1.5:1	Outside	Sheet	Very good	●			●	●	●	Best for deep draw items except where lip also requires severe draw, e.g.>1:2, in that area.
Billow-plug	1.5:1	Inside	Mold	Fair to good		●	●		●	●	Use for deep draw items where heavier wall is needed in certain lip configurations.
Billow snap-back	1.7:1	Outside	Sheet	Good	●			●	●	●	Uses generally the same as for Vacuum snap-back forming.

[a]Based on best actual experience up to date this guide was prepared. [b]Assumes exterior surface to be textured, interior texturing not yet encountered. [c]Sandwich heaters recommended for all sheet thicknesses over 100 mils (0.100-inch).

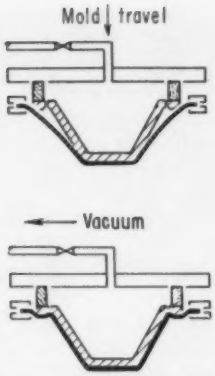

FIG. 4: MALE DRAPE FORMING: Operation similar to Fig. 3, except mold advances downward into sheet.

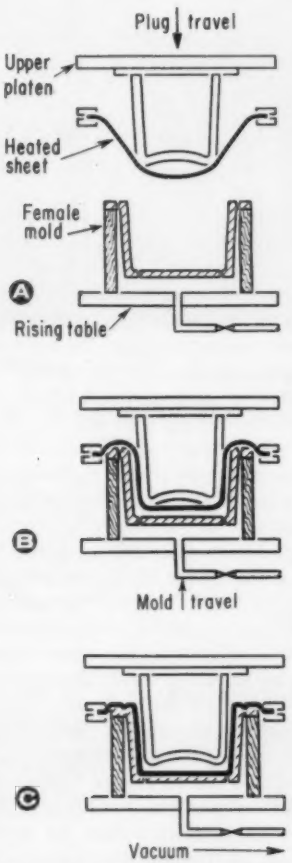

FIG. 5: PLUG-ASSIST FORMING: a) male-forming plug is advanced into clamped heat sheet; b) entire assembly advances into female mold cavity where; c) vacuum is applied to pull the sheet against the walls of the cavity, thus forming the part.

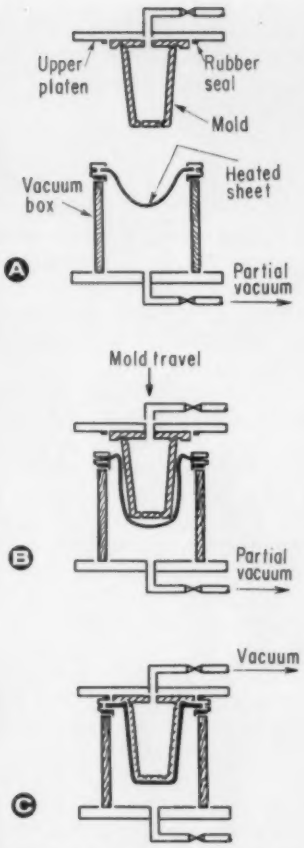

FIG. 6: VACUUM SNAP-BACK: a) sheet is clamped and heated in a box to which a partial vacuum is applied; b) male-forming plug advances into sheet; c) full vacuum is applied to the forming plug, which causes the sheet to fit snugly around the plug.

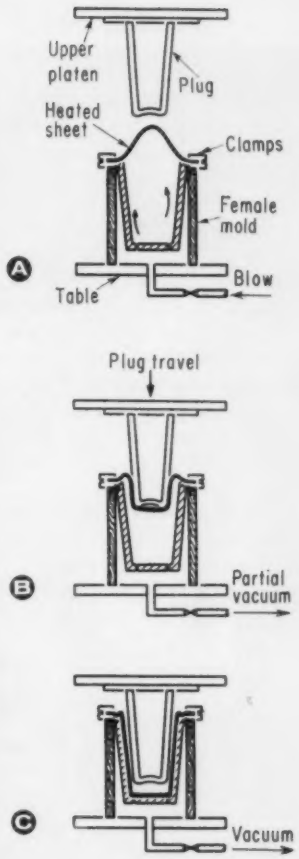

FIG. 7: BILLOW - PLUG: a) clamp and heated sheet is billowed by air pressure admitted through the cavity; b) plug travels into billowed sheet, pressure is released and partial vacuum is applied to the cavity; c) full vacuum is applied to cavity, thus pulling the sheet to the walls of the mold.

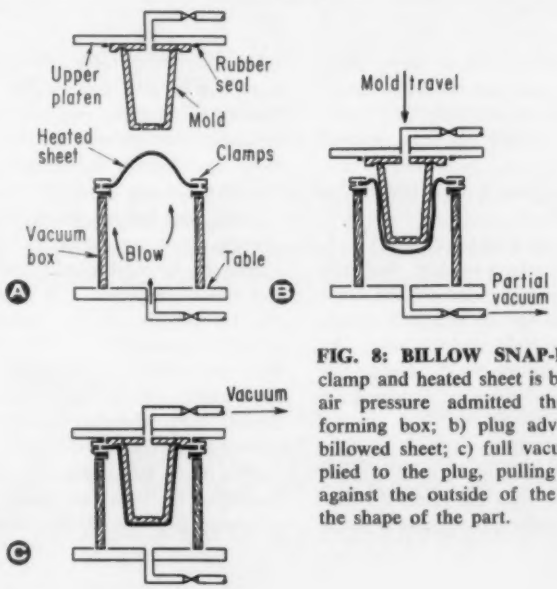

FIG. 8: BILLOW SNAP-BACK: a) clamp and heated sheet is billowed by air pressure admitted through the forming box; b) plug advances into billowed sheet; c) full vacuum is applied to the plug, pulling the sheet against the outside of the plug into the shape of the part.

polyolefin sheet would not yield the transparent canopies usually produced by this procedure. And certain proprietary techniques are not covered for obvious reasons.

Of the numerous procedures for vacuum forming which are known, the oldest is probably straight vacuum forming, *i.e.* where the sheet is held against the top of a female mold at the start of the heating cycle. However, this technique is seldom feasible with the high-density polyolefins because the sheet will sag appreciably as it is heated. Hence, we jump to drape forming for the first practical techniques with these materials.

Female drape forming is shown schematically in Fig. 2. The mold may rise to meet the sheet or the clamps may bring the sheet down over the edges of the mold to give the same effect. Not indicated in Fig. 2 is the use of air, blown back through the vacuum holes after the part is sufficiently cool, to help release the part from the mold. This last step is common to all of the techniques to be discussed.

In female drape forming, maximum thinning occurs where the vacuum must pull the sheet the greatest distance before the sheet contacts the mold. Conversely, the maximum thickness of material is found where the sheet first contacts the mold, generally along the top edges. Since differences in wall thickness may become excessive, this technique should be limited to parts with relatively little draw.

The "draw" or "draw ratio" of a female mold may be taken as the ratio of the maximum cavity depth to the minimum span across the top opening. Best results have been achieved in the female drape forming of high-density polyolefin sheet when this ratio did not exceed 0.7:1. However, even below this limit, plug-assist forming should be considered.

Male drape forming. From Fig. 3, it is, of course, evident that the steps in this technique are the same as those in female drape forming, although a male mold is used. As before, either the mold table or the clamps may move to bring sheet and mold in contact.

However, because some stretching or "preforming" of the sheet can occur before the vacuum is applied, the sidewalls are often more uniform than those obtained with a female mold. In addition, more material is utilized in male drape forming, other factors being equal. All of the sheet from the top of the mold to the edge of the mold base, as shown in Fig. 3B, is available for forming whereas, with a female mold (see Fig. 2B), only the sheet within the top edges of the cavity is usable. This is because there is little if any slippage over the edges into the cavity with high-density polyethylene as well as the ethylene copolymers.

For these reasons, it is often possible to go to somewhat higher draw ratios than are practical in female drape forming. Draw ratios of up to 1:1 have been employed successfully in the male drape forming of high-density polyolefin sheet. Draw ratio is defined here for a male mold as the ratio of the maximum form height to the minimum dimension at the base of the part form.

Following the general rule, however, maximum thinning will still occur at those points most remote from where the sheet first contacts the mold. Thus, with a male mold, the parts will be thinnest around the base of the part form and thickest at the top of the mold. Where the top surface is flat, it is not unusual for the final thickness of the part in this area to be *almost* equal to the thickness of the original sheet. The latter effect again shows that the molten sheet does not slide across the mold surface to any significant extent. This is characteristic of the high-density polyolefins.

A problem encountered more frequently in the male drape technique than any other is "webbing," *i.e.*, where the sheet folds over against itself while still hot. Proper mold spacing and various ring assists may be used to eliminate this difficulty. With the female drape technique, webbing is much less likely to occur.

Male and female drape forming are the most common techniques employed for high-density polyolefins today. However, this is due to the limitations of the equipment which is generally available, rather than to specific advantages of these techniques. When used for high-density polyolefin sheet, a vacuum-forming machine equipped *only* with a single, fixed platen (table) is restricted to these two basic types of drape forming. More advanced and versatile machines, provided at least with an upper, movable platen (plugging attachment) and precise, automatic control for several different operations in assorted combinations, are capable of producing a much wider range of quality parts from high-density polyolefin sheet.

Inverted male drape forming. To paraphrase an old political adage, "If you can't beat the sag, use it." Inverted male drape forming accomplishes just that, utilizing the sag of high-density polyolefin sheet during the forming operation to good advantage. With a minimum of tooling, excellent parts have been produced from male molds of large area by this technique. The only requirement is that a vertically-movable platen be available above the clamps for mounting the mold in an inverted position.

Inverted male drape forming is illustrated in Fig. 4 with the exception that gravity alone replaces the partial vacuum (as well as the vacuum box) that is employed in the vacuum snap-back thermoforming technique.

Inverted male drape forming is well suited for large-area molds, particularly when the high-density polyolefin sheet to be formed is over 125 mils in thickness. Nevertheless, it is limited to draw ratios of roughly 1:1 because the effect of gravity is slow and only time and sheet temperature can be used to control the resultant preforming.

By "preforming," we refer to any stretch or drawing of the sheet before it is finally pulled against all sides of the mold with full vacuum (26- to 28-in. Hg). Preforming is important in the thermoforming of high-density polyolefins, especially since the molten sheet does not slip on the mold surfaces. For maximum draw ratios and optimum sheet distribution, the shape must be "roughed in" before the sheet is pulled against the mold.

Plug-assist forming. Because a plug and a female mold are employed in this technique, two variations are possible. Either the plug may move down before the mold moves up (plug-first variation) or the mold may move up before the plug moves down (drape-first variation). From our early work, we discarded the latter variation since we found it less suitable for high-density polyolefins. Therefore, the

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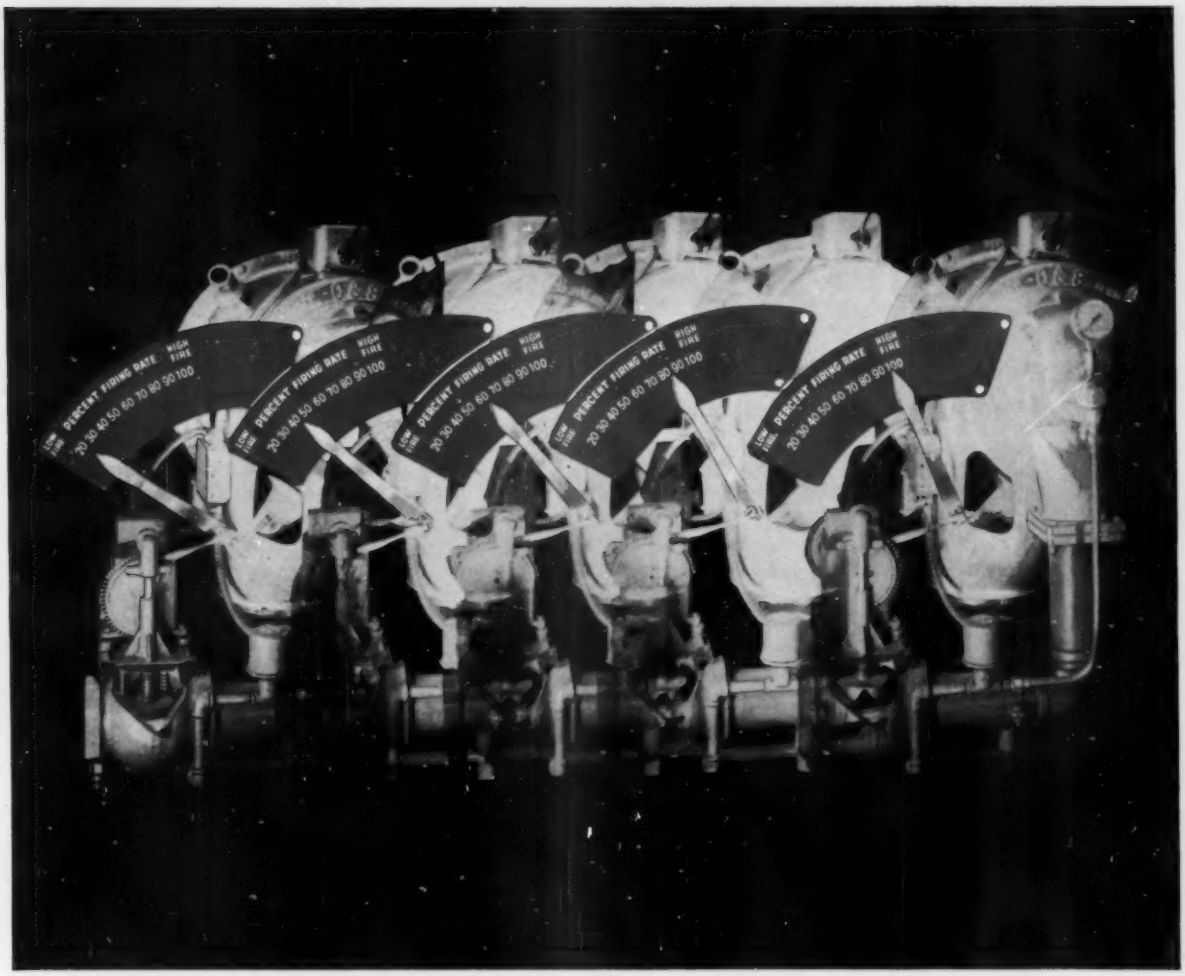

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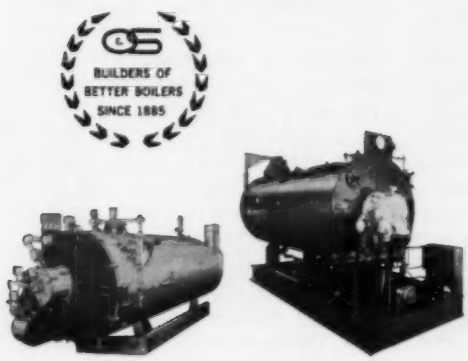

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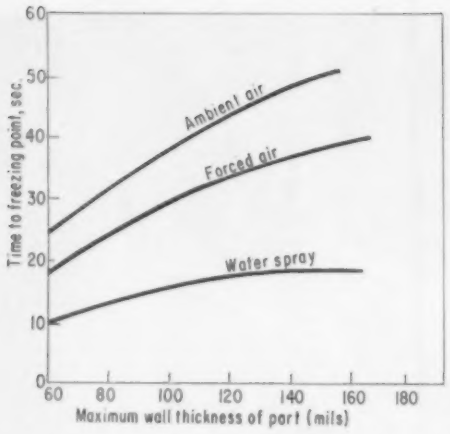


FIG. 9: Cooling time vs. maximum wall thickness.

following comments will pertain particularly to the plug-first procedure shown in Fig 5.

The plug should have excellent heat-transfer qualities and be capable of withstanding elevated temperatures (around 340° F. at the surface) for extended periods. Hence, we recommend plugs which are cast, machined, or otherwise fabricated from aluminum. On the other hand, the temperature control of the plug is not as critical as that which is required for the mold itself. Ordinary strip heaters with "on-off" thermostatic control will suffice.

Excellent results have been obtained by shaping the plug to conform to the general shape of the mold cavity but about 10 to 20% smaller in length and width (or diameter) where these dimensions are on the order of 5 in. or more. For a smaller plug, these dimensions should be reduced by *more than* 20%—allowing at least a ½-in. clearance where practical—since insufficient clearance can cause nonuniform thinning. In all cases, the effective height of the plug should be greater than the cavity depth to provide an adequate range of adjustment. Furthermore, all corners should be very generously radiused.

Plug-assist forming combines the principles of thinning discussed above for both male and female drape forming. That is, the cooling effect of the plug tends to put more material at the bottom of the part while the effect of drawing the sheet into the cavity is to thin out the bottom more. By judiciously balancing these two effects, excellent wall uniformity can be obtained. Optimum results have been achieved with plug penetrations of 70 to 80% of the cavity depth. With greater penetration, the bottom becomes thicker at the expense of other areas and, with less penetration, the bottom becomes too thin.

To help avoid "mark-off" problems, the *surface* temperature of the plug should be maintained at about 340° F. This is well above the crystalline melting points of these polyolefins, but probably just below the actual sheet temperature at the time of forming. Too much heat can be withdrawn from the sheet, causing slight "mark-off," unless contact time between the plug and hot sheet is also minimized.

Plugging speeds of up to 22 in./sec. have been evaluated and no problems were encountered. However, mold speeds may be restricted by the air pressure developed between the sheet and the mold as the mold moves up around the plug. This pressure keeps the sheet away from the mold and against the plug (Fig. 5B), allowing more material to be drawn into the cavity for better material distribution. If this pressure gets too high, due to excessive mold speeds and/or insufficient clearance, it can blow a hole in the sheet.

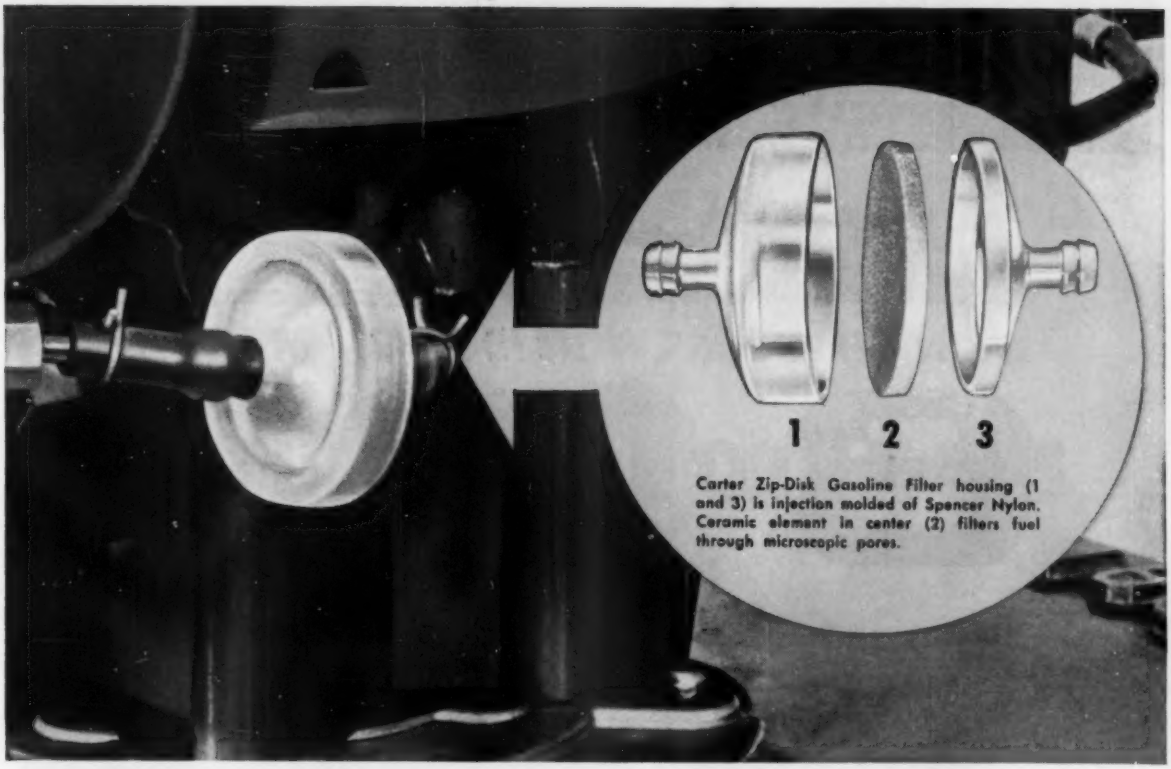
For deeper or otherwise more difficult formings, it may become necessary to withdraw some of the air from under the sheet as the mold moves upward. The rate of evacuation should then be sufficient to prevent excessive pressures from developing but should also be less than the rate of displacement of the air by the plug.

The use of a plug will, of course, add to the initial tooling costs, but this may be quickly regained in material savings. Plugging procedures provide a substantial improvement in wall uniformity and so permit the use of lighter-gage sheet to form the same parts. To illustrate the improvement which is possible, a number of various kinds of boxes have been formed by both female drape and plug-assist techniques in the same mold and starting with 187-mil sheet in both instances. With drape forming, the boxes exhibited a variation in wall thickness at one cross section of 0.120 in., compared to 0.029 in. obtained by plug-assist forming. Thus, plugging reduced the variation down to only 25% of the best we could do by simple drape forming.

Vacuum snap-back forming. In this technique, the preforming step can be controlled more closely than in inverted male drape forming while still avoiding the mechanical contact which is inherent to plug-assist forming. Thus, the vacuum snap-back technique is ideal for producing many deep-drawn items from high-density polyolefin sheet. Already, draw ratios of 1.5:1 have been demonstrated with excellent results and still further advances are predicted.

In Fig. 6 is shown the full procedure required for the highest draw ratios. For these, the application and control of the partial vacuum in the vacuum box are exceedingly important. The vacuum is applied in two steps to accomplish two different results. The first-stage vacuum (Step B), which draws the sheet into the box initially, serves to thin out that area which will become the bottom of the final part. The amount of thinning will depend, of course, on how far the sheet is drawn. As a general rule, the center will thin roughly 50% if the sheet is drawn to a depth equal to 50% of the minimum clamp opening. When the bottom of the mold contacts the sheet, essentially no more thinning occurs in this area. The second-stage vacuum (see Step C) then serves to distribute the adjacent areas which will become the sidewalls of the finished item.

For draw ratios below 1.5:1, the second-stage vacuum may not be needed. For large-area but still shallower parts, the **(To page 199)**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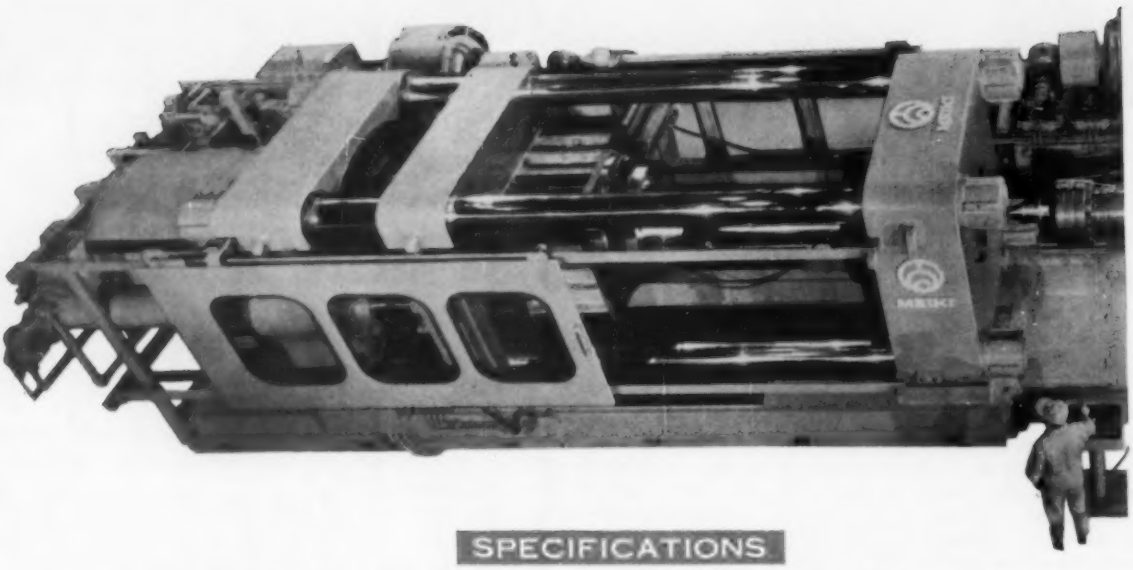
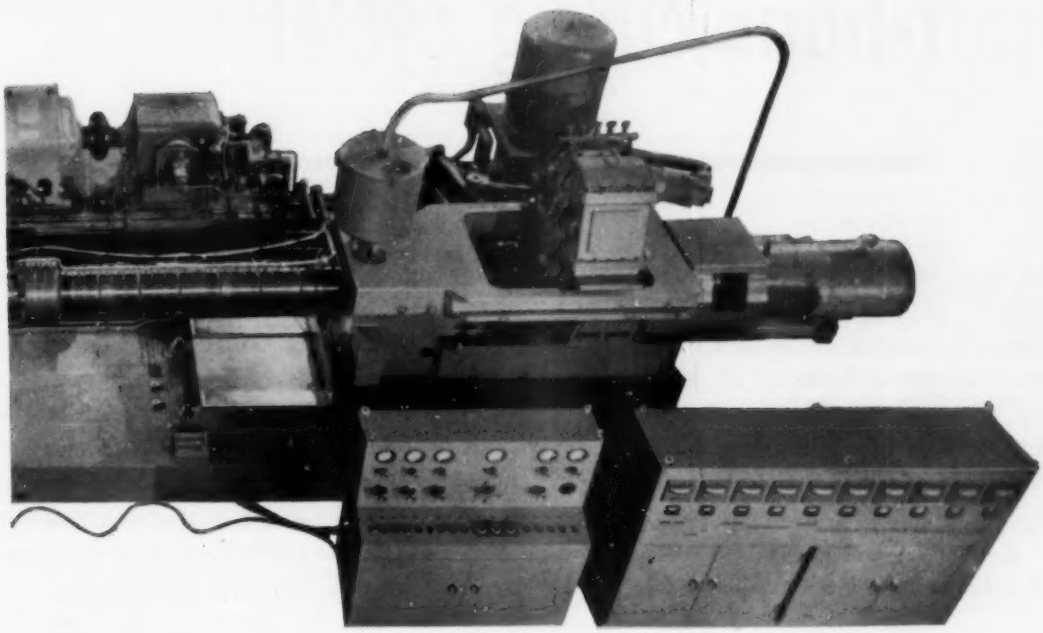


SPECIFICATIONS

MODEL		SJ - 35	SJ - 50	SJ - 60	SJ - 75	SJ - 90	SJ - 120	SJ - 150
Screw dia	in	1 3/16	1 31/32	2 23/64	2 61/64	3 35/64	4 23/32	5 29/32
Inj. pressure (max)	psi	14,500~ 23,000	16,500~ 28,000	15,500~ 28,000	15,500~ 28,000	16,000~ 30,000	14,500~ 30,000	10,000~ 28,000
Maximum Injection capacity per shot	oz (gr)	6 (170)	16 (455)	32 (910)	72 (2,400)	120 (3,400)	360 (10,400)	1,100 (31,000)
Clamping force	US ton	84	195	310	480	850	1,250	2,500
Clamping stroke	in	11 13/16	17 23/32	21 21/32	31 1/2	35 7/16	36 1/4	71

1100 OUNCES



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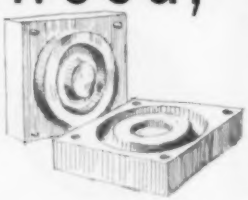
...permits use of wood, plaster, or clay models  with a **half-hour** curing cycle!

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PLASTICS* TECHNICAL SECTION

MATERIALS • PROPERTIES • TESTING METHODS AND INSTRUMENTATION • STANDARDS • CHEMISTRY

Formable thermosetting acrylic polymers

By Earl E. Parker† and Thomas L. St. Pierre†

Transparent thermosetting plastics suitable for use in high-speed military aircraft have been developed. Flat, essentially thermoplastic sheets at an intermediate stage of cure are prepared, which are stable for long periods at room temperature. Upon heating to 110 to 300° F. these sheets can be stretched or formed in conventional molds. The cure of the formed specimens can be completed by heating to temperatures of 300 to 500° F. An intermediate treatment with ionizing radiation is required for the curing of stretched specimens.

Optimum results were obtained with a two-component system containing diallyl itaconate and styrene and a five-component system containing diallyl itaconate, styrene, triallyl cyanurate, allyl methacrylate, and methyl methacrylate. Both of these products could be formed or multiaxially stretched at an intermediate stage of cure. Multiaxial stretching increased the K-toughness factor but not high enough to eliminate the necessity of lamination. All of the other target physical properties were either reached or closely approximated. This is the first example of successfully stretching thermosetting acrylic compositions with heat distortion temperatures in the 500° F. range.

The object of the work reported in this article was to develop a thermosetting acrylic polymer that would be suitable for windows in high-speed military aircraft. It was desired that this product should have a stable, formable, stretchable intermediate stage as well as the physical properties that are enumerated in Table I, p. 135, in the fully cured condition.

Work in the field of thermosetting transparent polymers began in our laboratories in the '30's. A group consisting principally of Muskat, Strain, Pollack, and Chenicek now holds over 50 U. S. Patents in the area of homopolymers and copolymers of allyl, acrylic, and vinyl compounds. Techniques developed in the course of this work, which proved to be useful in the present investigation, are:

1. A prepolymer or sirup can be prepared from many monomer combinations. This technique reduces the shrinkage of the casting to some extent and makes the material easier to handle in some of the applications.

2. The cure of the castings can be interrupted when the polymer is in a formable condition. The polymer can be shaped as desired and the cure completed.

3. Satisfactory products can often be prepared from monomer mixtures in which groups of quite different reactivities are utilized. The following classes of monomers were used in this work: 1) unsaturated esters of unsaturated monobasic acids; 2) esters of polyols and unsaturated monobasic acids; 3) glycol bis(allyl carbonates); and 4) esters of unsaturated alcohols and polybasic acids.

More recently Saxty, Johnson, and de Gooreynd (1, 2)[1] have extended this work with particular emphasis on the commercial production of useful products prepared from mixtures of monomers. According to U. S. Patent 2,910,-456, all three of the preceding procedures were used by these workers. Most of the examples in their patents disclose products consisting of castings of a three-component mixture of a monofunctional, a difunctional, and a trifunctional monomer. Allyl and methacrylate unsaturated groups predominate.

Screening program

The present work started with a screening program to determine the copolymer systems that might best meet the requirements listed in Table I. This was done by catalyzing an appropriate monomer mixture with 1% benzoyl peroxide and 1% di-*tert*-butyl peroxide and placing the mixture in a ⅛-in. casting cell. The cell was heated at 135° F. until a solid thermoplastic sheet was obtained or until it was obvious that the mixture would not polymerize at this temperature; in the latter case the temperature was increased. The testing procedure for ⅛-in. thick sheets made in this way began with the screening of 1 by 4 in. test specimens by subjecting them to the following cure schedule: 2 hr. at 250° F., 2 hr. at 300° F., and 2 hr. at 400° F. If the specimens survived this treatment with no apparent loss of physical integrity, the flexural strength and heat distortion temperatures were determined on other specimens postcured in the same manner. The more promising materials in this

*Reg. U. S. Pat. Off.

†Paint and Brush Division, Research and Development Center, Pittsburgh Plate Glass Co., Springdale, Pa.

Presented at the 1960 fall meeting of the American Chemical Society. This research was reported in part by the United States Air Force under Contract No. AF 33(616)-5602 monitored by the Materials Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio.

[1]Numbers in parentheses designate references at end of article, p. 209.

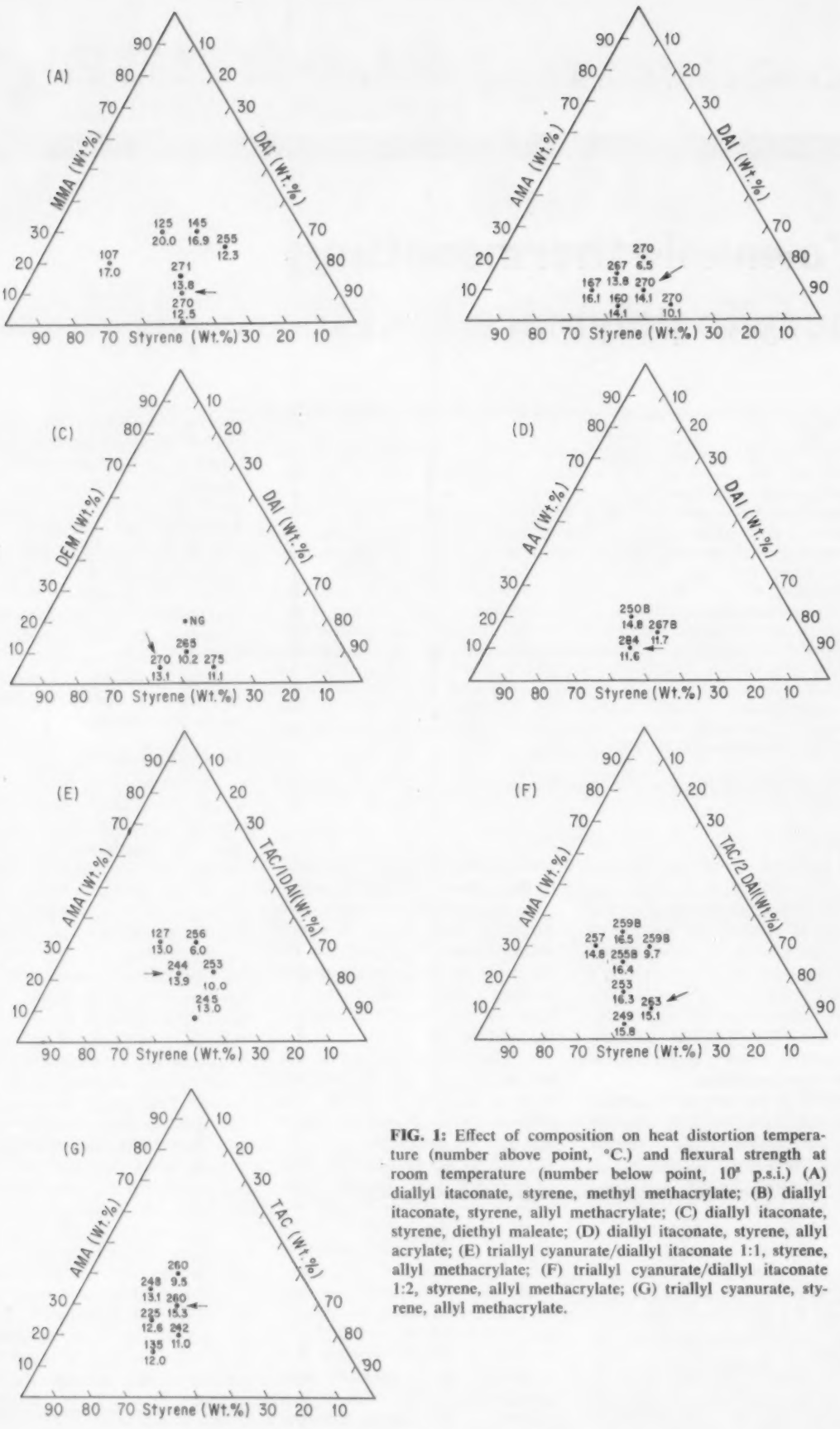

FIG. 1: Effect of composition on heat distortion temperature (number above point, °C.) and flexural strength at room temperature (number below point, 10^3 p.s.i.) (A) diallyl itaconate, styrene, methyl methacrylate; (B) diallyl itaconate, styrene, allyl methacrylate; (C) diallyl itaconate, styrene, diethyl maleate; (D) diallyl itaconate, styrene, allyl acrylate; (E) triallyl cyanurate/diallyl itaconate 1:1, styrene, allyl methacrylate; (F) triallyl cyanurate/diallyl itaconate 1:2, styrene, allyl methacrylate; (G) triallyl cyanurate, styrene, allyl methacrylate.

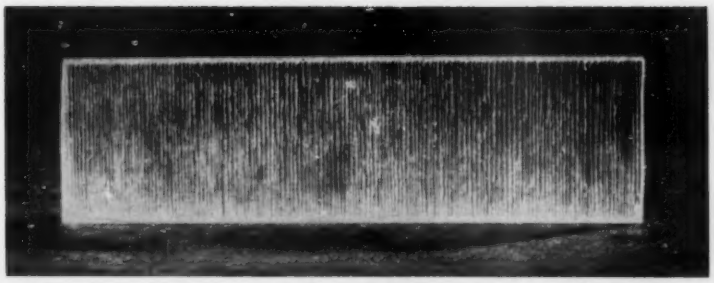

FIG. 2: Cracking of uniaxially stretched plastic during irradiation.

particular group were selected for further evaluation.

The selection of copolymer systems was based on the idea that each system should contain one set of reactive double bonds that would tend to react selectively with each other to form an essentially linear polymer and a less reactive set of double bonds that could be made to crosslink this thermoplastic material at a later time and at a higher temperature. Furthermore, it was assumed that each copolymer mixture should contain at least one trifunctional monomer and one monofunctional monomer. The highest physical properties were obtained with systems based on diallyl itaconate or triallyl cyanurate as the trifunctional material. Methacrylonitrile, styrene, and methyl methacrylate gave the best results as monofunctional monomers. These systems were further modified with other mono-, di-, and trifunctional monomers to produce the desired physical properties. Systems with five or more components were studied.

Table II, right, shows the properties of three of the two-component systems. Polymers containing methacrylonitrile had excellent physical properties, but their color varied from orange to red, depending upon the quantity of methacrylonitrile that they contained. Polymers containing styrene had somewhat poorer physical properties at room temperature but had better properties at temperatures that were more elevated.

Composition II in Table III, pp. 138-139, shows additional physical properties of the diallyl itaconate and styrene copolymer. This composition met or exceeded the target properties in all respects with the exception of flexural strength at 77° F., haze, and K-toughness factor. It was subsequently found that the flexural strength could be increased to the order of 15,000 p.s.i. by a longer postcure at a lower temperature than was used here. Modifications of this basic system were studied in an attempt to obtain a better product.

Figure 1A, p. 134, shows the triangular graph that was used to study the system diallyl itaconate, styrene, methyl methacrylate. Many of the compositions tested were deleted from the triangular graphs for the sake of clarity. The arrow on the graph designates the composition that was selected for further testing. In this case the optimum composition was 45 parts diallyl itaconate, 45 parts styrene, and 10 parts methyl methacrylate. The physical properties obtained with this formulation are shown in Table III under Composition III. Note that an improvement in flexural strength at 77° F. was obtained at a sacrifice of the flexural strength at 480° F.

Figure 1B shows the results of modification with allyl methacrylate. The material consisting of 45 parts diallyl itaconate, 45 parts styrene, and 10 parts allyl methacrylate was selected for further evaluation. This material (Table III, Composition IV) came pretty close to meeting our requirements

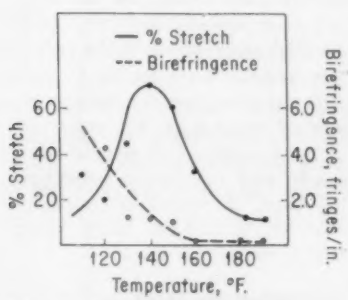

FIG. 3: Relationships between temperature of stretching and the degree of stretch and birefringence values.

Table I: Target properties for stretchable, formable, thermosetting, transparent plastic

Flexural strength at 77° F., unnotched (min.), p.s.i.	16,000
Flexural strength at 480° F., unnotched (min.), p.s.i.	3,000
Flexural modulus at 77° F., unnotched (min.), p.s.i.	450,000
Flexural modulus at 480° F., unnotched (min.), p.s.i.	70,000
Color at 425° F.	Colorless
K-toughness factor (when oriented)	2300
Luminous transmittance, min., %	88
Haze, max., %	1.5
Stress crazing at 77° F. under 7500 p.s.i. stress for 10 days	None
Heat distortion temperature, °F.	480

Table II: Preliminary two-component systems[a]

Property	*Compositions* 50% DAI 50% MAN	50% DAI 50% S	50% DAI 50% MMA
Flexural strength at 77° F., p.s.i.	14,600	12,200	5,400
Flexural modulus at 77° F., p.s.i.	700,000	460,000	560,000
Heat distortion temperature, °F.	464	>518	392

[a]Code for abbreviations: DAI—diallyl itaconate; MAN—methacrylonitrile; MMA—methyl methacrylate; S—styrene.

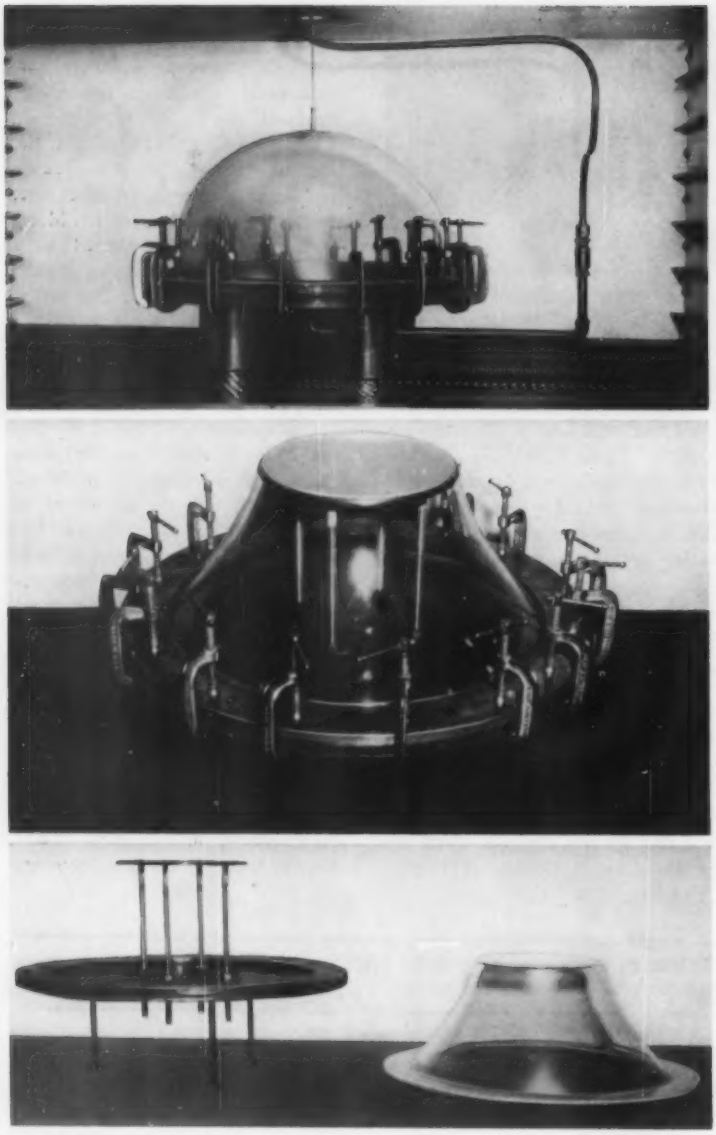

FIG. 4: Preparation of biaxially stretched plastic specimen for determination of K-toughness factor. (A), top photo, apparatus to blow dome; (B), middle photo, assembly for shrinking dome; and (C), bottom photo, "top hat" after its removal from the apparatus.

with the exception of the K-toughness factor. Figure 1C shows the results of modification of the diallyl itaconate and styrene system with diethyl maleate. Again a 45:45:10 mixture appeared best. The physical properties of the optimum composition (Table III, Composition V) are somewhat inferior to those obtained by the use of allyl methacrylate. Modification with allyl acrylate (Fig. 1D) also gave the best results with the 45:45:10 mixture; the physical properties (Table III, Composition VI) were inferior to those obtained with allyl methacrylate.

In Fig. 1E, a 50:50 mixture of triallyl cyanurate and diallyl itaconate was considered a single component so that a four-component system could be studied by the same general method. The other two components were styrene and allyl methacrylate. The optimum composition proved to be 20 parts diallyl itaconate, 20 parts triallyl cyanurate, 50 parts styrene, and 10 parts allyl methacrylate. The properties (Table III, Composition VII) were not quite as good as some of the others with the exception that the tensile strength obtained was substantially higher.

The use of a mixture containing 2 parts diallyl itaconate to 1 part triallyl cyanurate gave considerably better results (Fig. 1F). The optimum composition proved to be 30 parts diallyl itaconate, 15 parts triallyl cyanurate, 10 parts allyl methacrylate, and 45 parts styrene. The physical properties of this material are shown in Table III under Composition IX.

Figure 1G shows the results obtained on a three-component system consisting of triallyl cyanurate, allyl methacrylate, and styrene. The composition consisting of 30 parts triallyl cyanurate, 30 parts allyl methacrylate, and 40 parts styrene was chosen for further evaluation. Although a heat distortion value of 511° F. was obtained on this system (Table III, Composition X), the test specimens crazed during the heating cycle so that no values for the flexural strength at 480° F. could be obtained.

For systems containing more than four components, the method of triangular graphs was abandoned in favor of a statistical approach. The five-component system, triallyl cyanurate, diallyl itaconate, styrene, allyl methacrylate, and methyl methacrylate, was studied in this manner. Composition X in Table III shows the properties of one of the better compositions arrived at in this manner. This composition also had low strength at 480° F. A better combination of the same five components is shown under Composition VIII. This material contains 20 parts diallyl itaconate, 12 parts triallyl cyanurate, 20 parts styrene, 9 parts allyl methacrylate, and 39 parts methyl methacrylate. This composition had very good physical properties with the exception of flexural strength at 480° F.

It was concluded that the copolymer of equal parts by weight of diallyl itaconate and styrene most nearly met the target properties. However, if flexural strength at 480° F. is waived, Composition VIII gave the best results.

Stretching program

Since it was necessary to conduct the stretching experiments simultaneously with the screening

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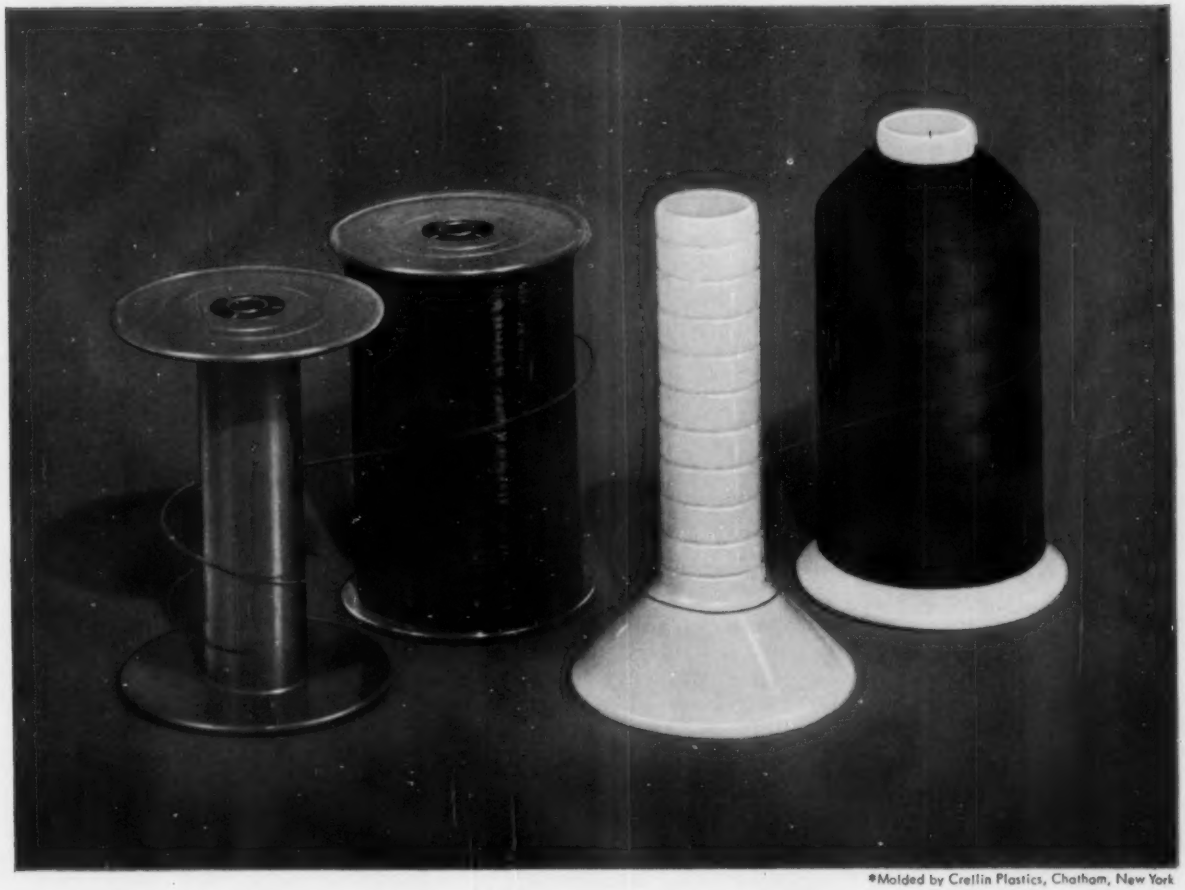

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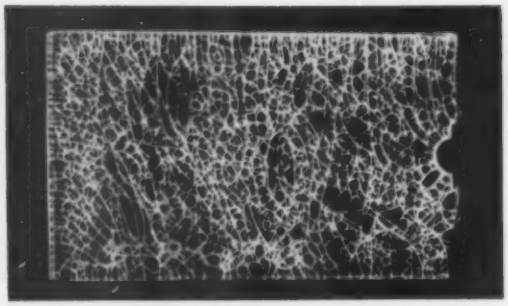

FIG. 5: Cracking of multiaxially stretched plastic during irradiation. Note random curved pattern.

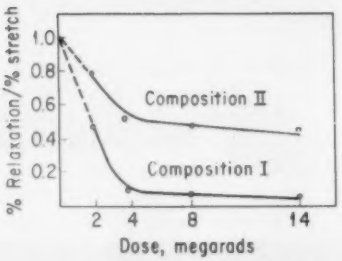

FIG. 6: Effect of composition (see Table III) on dimensional stability during irradiation.

work, the first stretching experiments were run on a polymer that was available to us from earlier work. This material, which we have designated Composition I, contained 20 parts triallyl cyanurate, 15 parts allyl methacrylate, and 65 parts methyl methacrylate. In the first set of experiments, test strips of Composition I were heated in an oil bath at 200° F. and then stretched in a tensile testing machine. These specimens were exposed to laboratory air at room temperature during the stretching period. It was found that Composition I could readily be stretched 75% uniaxially by this method.

The stretched specimens were then exposed to a dosage of 5 megarads in a linear accelerator to partially postcure the specimens and to lock in the stretch. No way has been found to do this thermally without rupturing the specimens. This is because the force required to maintain the specimens in the stretched condition is greater than the tensile strength of the specimens at the temperature required to postcure them effectively. The irradiated specimens were then heated for 2 hr. at 325° F. to complete the postcure. During this treatment all of the specimens developed a series of parallel cracks perpendicular to the direction of the stretch (Fig. 2, p. 135). It was found that specimens that contained a stretch of less than 35% could be processed without this failure.

Birefringence measurements were taken on the centers of the above specimens before and after the irradiation step. Specimens stretched 75% were found to have an average birefringence of about 2.3 fringes per in. before irradiation and 6.5 fringes per in. after irradiation. Measurements on the edges of the specimens were close to zero. This led to speculation that the stress cracking might be due to a temperature differential in the test piece during the stretching operation. In order to check this point, a second set of specimens was stretched under constant temperature conditions using a static load in a circulating-air oven. The stretching temperature was varied between 110 and 300° F., and the optimum load was determined by trial and error. The stage of cure was also varied by starting with the lowest cure possible and postcuring to various extents.

It was found that stretched Com-

Table III: Physical properties

	Compositions[a]					
Property	*I 20% TAC 15% AMA 65% MMA*	*II 50% DAI 50% S*	*III 45% DAI 45% S 10% MMA*	*IV 45% DAI 45% S 10% AMA*	*V 40% DAI 50% S 10% DEM*	*VI 40% DAI 50% S 10% AA*
Flexural strength at 77° F., p.s.i.	16,500	12,500	13,800	14,100	13,100	11,600
Flexural modulus at 77° F., p.s.i.	480,000	521,000	497,000	498,000	456,000	502,000
Flexural strength at 480° F., p.s.i.	None	3,500	2,300	2,900	2,200	None
Flexural modulus at 480° F., p.s.i.	None	188,000	133,000	188,000	121,000	None
Tensile strength at 77° F., p.s.i.	8,500	4,800	——	5,700	——	——
Tensile modulus at 77° F., p.s.i.	522,000	503,000	——	476,000	——	——
Heat distortion temperature, °F.	365	>510	>507	>507	487	514
Color at 425° F.	Amber	Amber	Amber	Amber	Amber	Amber
Luminous transmittance, %	90	88	——	——	——	——
Haze, %	1.6	1.7	——	——	——	——
Stress crazing at 77° F.	None	None	None	None	——	——
K-toughness factor[b]	196[0]	——	——	298[39]	——	——
	372[35]					
	693[21]					
	502[45]					
	534[55]					
	754[55]					
	865[50]					

[a]Code to abbreviations: DAI—diallyl itaconate; MMA—methyl methacrylate; DEM—diethyl maleate; TAC—triallyl cyanurate; S—styrene; AMA—allyl methacrylate; AA—allyl acrylate. [b]Superscripts denote degree of multiaxial stretch at which K-toughness factor was determined.

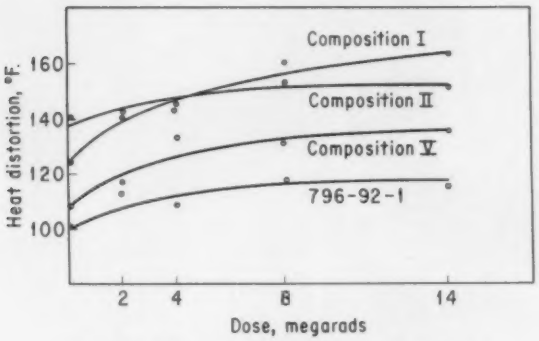

FIG. 7: Effect of composition (see Table III) on heat distortion temperature achieved by irradiation.

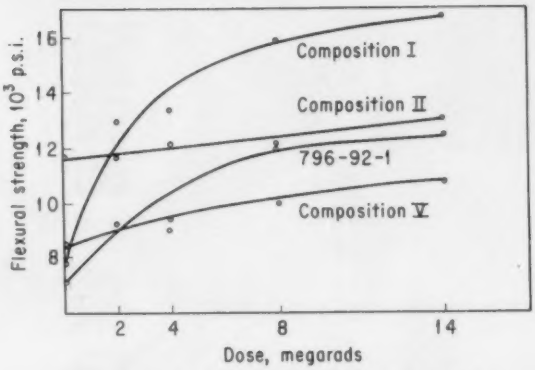

FIG. 8: Effect of composition (see Table III) on flexural strength achieved by irradiation.

position I at the lowest degrees of cure always showed a negative birefringence value. Postcuring this material before the stretching operation tended to shift the birefringence reading in the positive direction. The relationship between percent stretch, temperature of stretch, and birefringence values is shown in Fig. 3, p. 135, for one condition of postcure. The highest birefringence values were obtained when postcured material was stretched at the lowest possible temperature. It had been hoped that birefringence measurements could be used as an indication of the degree of stretch that was obtained.

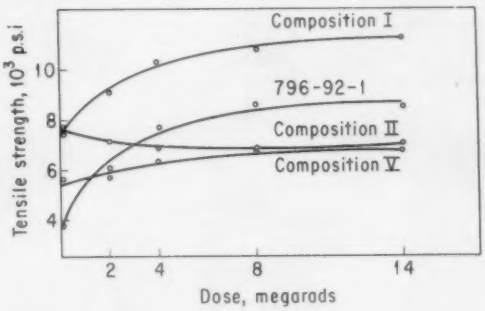

FIG. 9: Effect of composition (Table III) on tensile strength achieved by irradiation.

Figure 3 clearly shows that the temperature history of the test specimen can radically change the birefringence value, making these measurements completely useless as far as a quantitative measure of stretch is concerned.

Since it had been established that variables in the stretching procedure had no effect on stress crazing, we next turned our attention to the irradiation step. The use of gamma irradiation from a cobalt-60 source was found to cure Composition I as effectively as the electron beam of the linear accelerator. However, it did not improve the situation regarding stress cracking. Experiments designed to conduct the irradiation in the absence of oxygen showed that the stress cracking could be prevented by excluding oxygen during the irradiation step. The use of a protective plastic tape on the specimen during irradiation was found to be the most practical solution to the problem.

Multiaxial stretching

Although biaxially stretched thermoplastic materials have been used commercially for some time, there seems to be little precedent for the preparation of biaxially stretched thermosetting materials. No completely practical way of stretching sheets of Composition I biaxially has been **(To page 209)**

of experimental formulations

Compositions[a]				
VII	*VIII*	*IX*	*X*	*XI*
20% DAI	*20% DAI*	*30% DAI*	*9% DAI*	*30% TAC*
20% TAC	*12% TAC*	*15% TAC*	*23% TAC*	*30% AMA*
50% S	*20% S*	*10% AMA*	*28% MMA*	*40% S*
10% AMA	*9% AMA*	*45% S*	*17% AMA*	
	39% MMA		*23% S*	
13,900	17,700	15,100	16,100	15,300
553,000	528,000	589,000	569,000	519,000
None	None	1,600	None	None
None	None	153,000	None	None
8,200	8,400	7,100	7,800	8,800
495,000	528,000	517,000	561,000	536,000
480	491	>509	489	511
Amber	Amber	Amber	Amber	Amber
—	87	86	87	84
—	4.4	2.5	3.4	4.6
—	—	—	—	—
—	222^{20b} 250^{27} 251^{18}	—	—	—

[a]Code to abbreviations: DAI—diallyl itaconate; MMA—methyl methacrylate; DEM—diethyl maleate; TAC—triallyl cyanurate; S—styrene; AMA—allyl methacrylate; AA—allyl acrylate. [b]Superscripts denote degree of multiaxial stretch at which K-toughness factor was determined.

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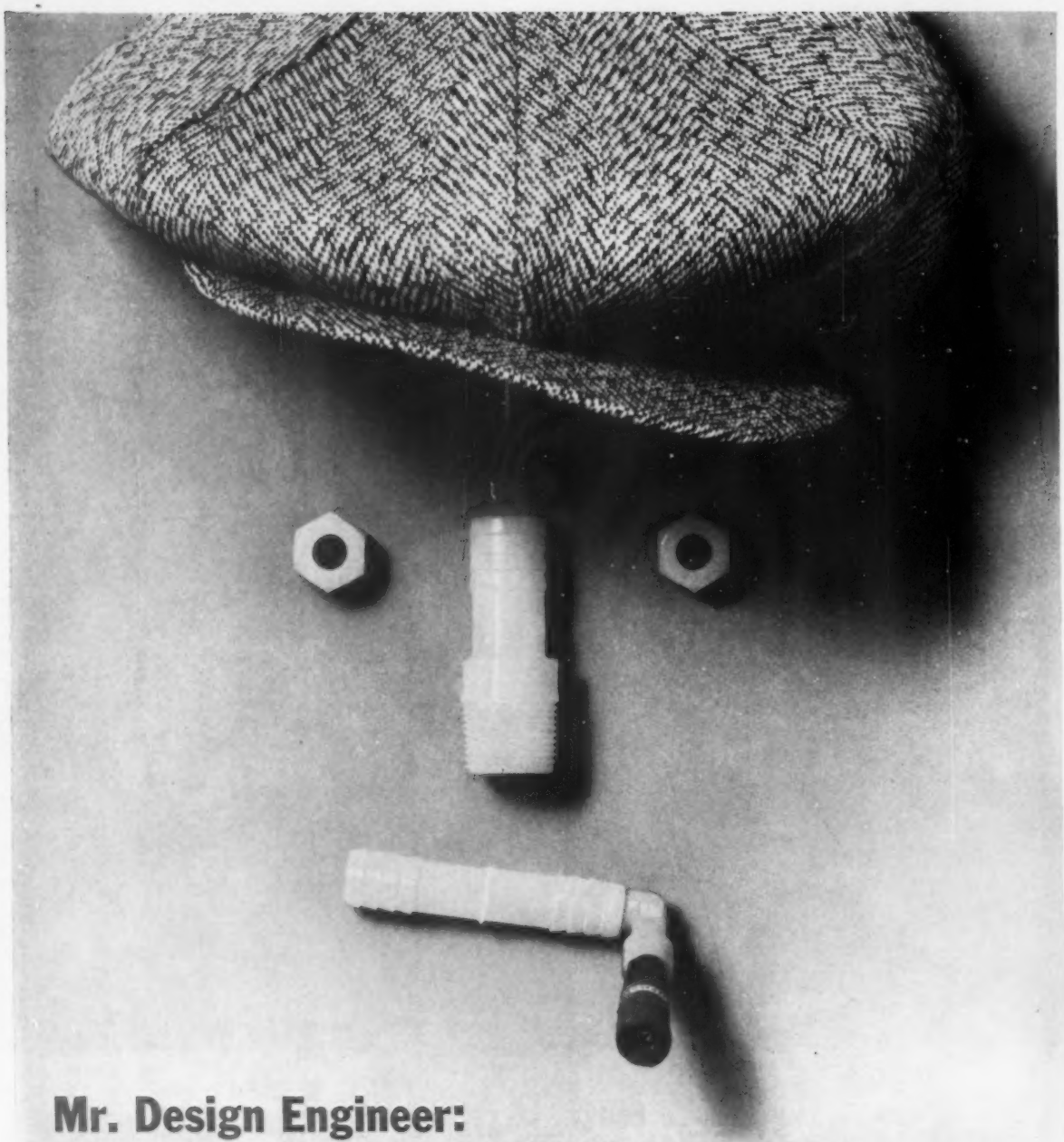

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Allylic resins and laminates

By Harry Raech Jr.* and J. L. Thomas*

Diallyl phthalate and its newer homologs have current applications in giant radomes, nuclear devices, electronic instruments, chemical equipment, ablative elements, dinnerware, and decorative laminates. There are a number of reasons for the interest in the allylic materials—chemical resistance to all reagents but the most powerful oxidizers, exceedingly low loss factors electrically, weathering characteristics virtually unexcelled among thermosets, mold shrinkage, and dimensional stability unique among thermosets, nonstaining characteristics, heat resistance to 500° F. and higher, and excellent wear resistance. These properties are accompanied by ease of fabrication. Diallyl phthalate molding compounds can be produced in parts of great intricacy in cycles as short as 15 sec., and prepregs can be vacuum or press molded with ease. All of the application forms are characterized by very lengthy shelf life and low volatility.

In its basic form, diallyl phthalate is a low-viscosity liquid of low-vapor pressure; in this form it is exceedingly difficult to process. When homopolymerized, it experiences shrinkage in excess of 10% and has a long cure time. Obviously, whatever the properties of a product successfully molded from such a material, the problems of molding are so great that the end hardly justifies the means. For this reason, diallyl phthalate is rarely, if ever, used as a homopolymer. Instead, the Dapon[1] process is used to create a usable, easily moldable, free flowing white powder which has negligible shrinkage, short cure cycles, and ready processability. Essentially, this material is a prepolymer of diallyl phthalate. For ready identification, it is referred to as Dapon 35. In this form, diallyl phthalate serves the electronic industry as insulators, connectors, resistor capacitor housings, and similar applications.

The monomer diallyl phthalate, however, has unusual characteristics which result in its broad usage in so-called polyester prepregs. In this application, it is usually combined with alkyd polyesters to the extent of 20 to 50% to form stable gel-like resins. It is also marketed as liquid laminating resins characterized by ease of handling and low volatility. From the viewpoint of processability, these combinations have a number of advantages. These

FIG. 1: Dapon M hot-air heater duct for Republic F-105 jet fighter.

Table I: Typical properties of alkyd-DAP prepreg[a]

Property	*Value*
	p.s.i.
Tensile strength	
Room temperature, dry	58,600
Room temperature, wet	51,700
250° F.	42,700
250° F., 45° to warp	16,900
250° F., fill direction	48,900
Flexural strength	
Room temperature, dry	70,000
Room temperature, wet	58,400
250° F.,	44,000
250° F., 45° to warp	27,700
250° F., fill direction	48,200
Compressive strength	
Room temperature, dry	36,700
Room temperature, wet	37,700
250° F.	32,600
250° F., 45° to warp	17,900
250° F., fill direction	32,100
Ultimate shear strength	
Room temperature, dry	22,700
Room temperature, wet	22,900
250° F.	17,900
Ultimate bearing strength at 250° F.	35,700
Tensile modulus of elasticity at 250° F.	2.7×10^6
Flexural modulus of elasticity at 250° F.	2.9×10^6

[a]14-ply laminate, 0.14-in. thick, 181 cloth, Volan A finish, cured at 275° F., 40 p.s.i. 30 minutes. All values at 250° F. were determined after 0.5 hr. at 250° F. Wet strength was determined after immersion in water for 24 hours. Tests were made in warp direction, unless otherwise specified.

Table II: Properties of Dapon 35 laminates[a]

Temp.	*Flexural strength*	*Flexural modulus*	*Tensile strength*	*Tensile modulus of elasticity*
°F.	*p.s.i.*	*10^6 p.s.i.*	*p.s.i.*	*10^6 p.s.i.*
Room	76,000	2.88	47,100	2.71
200	61,200	2.58	40,450	2.90
300	45,200	2.21	40,700	2.64
400	19,500	1.40	21,200	1.88

[a]12-ply laminates ⅛-in. thick containing 37.7% diallyl phthalate resin. The reinforcement was 181 glass cloth, Volan A finish. The resin mix consisted of 80:20 Dapon 35 and monomer, and 2% tert-butyl perbenzoate. Pressed at 280° F. and 100 p.s.i pressure for 30 minutes. Properties determined after 0.5 hr. at test temperature.

*Western District Mgr., Dapon Dept., and Plastics Engineer, ATS Laboratories, respectively, Food Machinery & Chemical Corp.

Based on a paper presented at the S. P. I. Reinforced Plastics Conference in Chicago, Ill., Feb. 1961.

[1]Trademark of Food Machinery and Chemical Corp.

include very long shelf life, excellent drape, almost ideal tack, making layup convenient and inexpensive, and a simple cure cycle requiring little or no postcure. From the viewpoint of application, such materials are usually chosen because of their outstanding electrical and weathering characteristics. A high percentage of military radomes are fabricated of such materials. Properties of such alkyd/DAP prepregs are shown in Table I, p. 143.

When diallyl phthalate is homopolymerized, a number of advantages are realized. Heat distortion point is raised about 100° F. over usual polyesters, chemical resistance increases, electrical properties, such as resistivity, increase markedly, while other electrical characteristics, such as loss factor, drop equally precipitously. Table II, p. 143, gives properties of laminates made from this type of material.

Not wholly unexpectedly, the isomer of diallyl phthalate, diallyl isophthalate (DAIP), yields consistently better properties. The heat distortion point of the resin is almost 200° F. higher than most alkyd polyesters and about 100° F. higher than diallyl phthalate. Electrically, it offers even lower dielectric constant than diallyl phthalate and higher arc resistance. In molding compounds, the physicals are about 10% higher at room temperature and even more at elevated temperature. Table III, below, gives some of the properties of diallyl isophthalate molding compounds. As was the case with diallyl phthalates, the DAIP monomer is quite difficult to homopolymerize. Therefore, the Dapon process was again used to prepare a free flowing white prepolymerized powder

Table III: Typical properties of molding compounds made from Dapon diallyl phthalate resin

Specification type	*Filler*	*Resin*	*Typical properties (top values in each class)*											
			Dielectric constant, 1000 cy.	*Arc resistance*	*Dissipation factor, 1000 cy., dry*	*Flexural strength*	*Flexural modulus*	*Compressive strength*	*Impact strength, Izod*	*Mold shrinkage*	*Post mold shrinkage (lifetime)*	*Water absorption at 122° F. in 48 hr.*	*Heat distortion temp.*	*Continuous heat resistance temp., max.*
				sec.		*p.s.i.*	*10^6 p.s.i.*	*p.s.i.*	*Ft.-lb./in. of notch*	*in./in.*	*in./in.*	*%*	*°F.*	*°F.*
MIL-M18794														
SDI-5	Orlon	Dapon 35	4.0	140	0.020	10,500	0.71	30,000	1.2	.009	.001	.2	265	350
SDI-30	Dacron	Dapon 35	3.6	125	0.008	12,000	0.64	30,000	4.5	.010	.0006	.2	290	400
		Dapon 35 (fr)[a]	3.6	125	0.008	12,000	0.68	32,000	4.5	.010	.0006	.2	290	400
SDG	Short glass	Dapon 35	4.3	125	0.004	11,000	1.3	26,000	.8	.002	.0005	.1	350	450
		Dapon M	4.12	180	0.004	15,000	1.3	30,500	1.2	.002	.0002	.1	450	500
		Dapon 35 (fr)	4.3	125	0.003	11,000	1.4	26,000	.9	.002	.0005	.3	320	450
		Dapon M (fr)	4.1	140	0.008	16,000	1.4	28,000	.9	.002	.0005	.3	450	500
MIL-M14														
MDG	Cellulose	Dapon 35	6.5	140	0.045	9,000		30,000	.4	.007	.001		325	450
MDG	Asbestos	Dapon 35	3.9	140	0.039	10,000	1.2	25,000	.4	.006	.001	.2	325	450
		Dapon M	4.0	190	0.031	13,000	1.2	32,000	.5	.006	.0007	.45	450	500
		Dapon 35 (fr)	4.5	140	0.08	10,000	1.3	26,000	.4	.006	.0007	.5	325	450
		Dapon M (fr)	4.4	150	0.38	13,000	1.4	28,000	.45	.006	.0007	.5	420	500
MDG	Mineral	Dapon 35	3.9	140	0.039	10,000	1.2	25,000	.4	.006	.001	.2	325	450
		Dapon M	4.0	190	0.031	13,000	1.2	32,000	.5	.006	.0007	.45	450	500
		Dapon 35 (fr)	4.8	140	0.02	6,800	1.2	25,000	.35	.004	.0006	.4	320	450
MIL-M19833		Dapon 35	4.1	125	0.004	17,000	1.25	29,000	6.0	.002	.0007	.2	392	450
GDI-30	Long glass	Dapon M	3.8	180	0.004	19,000	1.4	29,500	9.0	.002	.0002	.11	490	500
		Dapon 35 (fr)	4.1	125	0.004	18,000	1.3	30,000	7.0	.002	.0007	.29	392	450
		Dapon M (fr)	4.2	180	0.008	24,000	1.6	34,000	10.8	.002	.0007	.2	490	500
GDI-30	Very long glass	Dapon 35	4.5	140	0.009	22,000	1.4	28,500	8.0	.002	.0005	.27	400	400

[a] fr—fire resistant.

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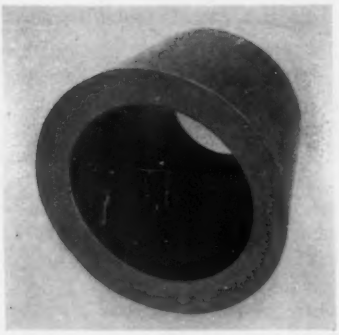
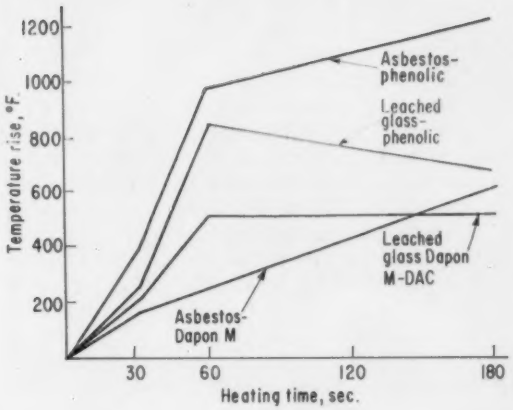


FIG. 2: Experimental rocket nozzle.

FIG. 3: Ablative insulating characteristics for a variety of molding compounds.



having low shrinkage and easy processability. This material is identified as Dapon M. Table IV, right, gives properties for its laminates. A typical application is shown in Fig. 1, p. 143.

A series of allylic homologs are available for copolymerization. They include diallyl phthalate, diallyl isophthalate, diallyl maleate, and diallyl chlorendate. In the cases of several of these, study is in the early stages although all are presently available in commercial quantities. Such monomers confer properties of heat resistance and, in the case of diallyl chlorendate, flame resistance, when used with Dapon 35 or Dapon M.

Table V, right, indicates the effect on castings of the addition of such allylics to Dapon M. The flexural strengths at 300° F, were significantly improved.

The effects of the addition of these allylic compounds to Dapon M in glass cloth laminates are indicated in Table VI, right. It may be observed that the combination of DAIP prepolymer and monomer confers the best physical properties, both at room and elevated temperatures of all combinations that were studied.

While diallyl chlorendate confers flame resistance to laminates, it also provides excellent physical properties. Table VII, p. 148, indicates the effect of combinations of diallyl chlorendate with Dapon M.

Other monomers, such as diallyl diglycollate and diallyl adipate have properties of potential interest. Data on compounds, utilizing Dapon 35 with these monomers, is shown in Table VIII, p. 148.

The part shown in Fig, 2, above, is an experimental nozzle now being evaluated by a solid propellant

Table IV: Properties of Dapon M laminates[a]

Temperature	*Flexural strength (tested at temp.)*	*Flexural modulus*	*Edgewise compressive strength*
°F.	*p.s.i.*	*10^6 p.s.i.*	*p.s.i.*
Room	62,000	3.21	—
250	44,500	—	—
350	38,500	2.03	12,200
450	22,300	—	—
500	15,400	2.12	4,600

[a]All data for ⅛-in.-thick 12-ply laminates of 181 glass cloth, Garan or A-172 finish. Curing conditions: 15 p.s.i., 285° F., 30 min.; post-cured 2 hr. at 350° F. Resin content: 38%. Resin mix: 75:25 Dapon M—DAIP monomer, and 3% tert-butyl perbenzoate.

Table V: Properties of cast Dapon M/DAM resins[a]

Property	*Dapon M-100%*	*Dapon M-90% DAM-10%*	*Dapon M-75% DAM-25%*
Flexural strength			
At room temp., p.s.i.	5,400	7,200	5,700
At 300° F., p.s.i.	2,600	4,100	2,700
Flexural modulus of elasticity			
At room temp., 10^6 p.s.i.	0.52	0.51	0.57
At 300° F., 10^6 p.s.i.	0.27	0.27	0.35
Heat distortion temp.[b]			
At 264 p.s.i., °F.	6 mils at 473	4 mils at 419	2 mils at 406
At 66 p.s.i., °F.	0 mils at 466	8 mils at 480	5 mils at 471
Rockwell hardness	M122	M122	M123

[a]Cured with 2% tert-butyl perbenzoate for 12 hr. at 60° C., 12 hr. at 90° C., and 12 hr. at 120° C. [b]Samples broke.

Table VI: Properties of glass-reinforced allylic laminates[a]

Property	*Dapon M/DAIP* 85/15	*Dapon M/DAIP* 70/30	*Dapon M/DAM* 85/15	*Dapon M/DAM* 70/30
Flexural strength				
At 73° F., p.s.i.	51,000	61,700	45,450	57,680
At 400° F. after 30 min., p.s.i.	33,800	45,600	40,400	34,600
At 400° F. after 100 hr., p.s.i.	28,200	44,500	34,600	34,900
Flexural modulus of elasticity				
At 73°F., 10^6 p.s.i.	1.61	—	1.3	1.6
At 400° F. after 30 min., 10^6 p.s.i.	1.35	1.65	1.96	1.45
At 400° F. after 100 hr., 10^6 p.s.i.	1.15	1.62	1.22	1.49
Resin content of laminate, %	47.0	42.0	49.0	41.0

[a]12-ply laminates, ⅛-in. thick, made with 181 glass cloth, Garan finish. Cured with 2% tert-butyl perbenzoate for 30 min. at 285° F. and 100 p.s.i. pressure and postcured 1 hr. at 300° F. DAIP=diallyl isophthalate. DAM=diallyl maleate.

rocket manufacturer. It may be noted that this part, which is molded from long fiber chrysotile asbestos and Dapon 35, exhibits the smooth surface usually associated with thermoplastics. This is a result of the good flow and low shrinkage of the material. The molding was made at about one-fifth of the pressure usually associated with molding of rocket parts, at a fraction of the time and with no required postcure. A typical cure for a part of this mass is 0.5 hr. at 285° F. and 600 p.s.i. This is a striking departure from the conditions usually associated with ablative materials.

To ascertain the ablative insulating qualities of the material, tests were made using an oxyacetylene torch so positioned that the flame temperature was about 500° F. and its effective impinged heat input about 50 B.t.u./sq. ft. per second. Heat transfer was measured by a thermocouple placed at the back of a ⅛-inch-thick specimen.

The temperature rise versus time is a measure of the efficiency of the system in insulating against the heat of burning of solid rocket propellants. A typical application might be the cylindrical internal lining of a rocket such as the Polaris. Since high temperature phenolic is the material generally found to excel in this insulating characteristic, compounds comprising this resin with both leached glass and asbestos were chosen as standards of reference and allylics were compounded using the identical reinforcements. Recalling that the burning time of a solid center burning rocket is roughly equal to its diameter in inches, 60 sec. heating time represents a 5-ft.-diameter rocket of the Minuteman class. In Fig. 3, p. 147, whereas leached glass phenolic molding compounds results in rise of 900° F. under the test conditions, asbestos-Dapon M reduces the rise to less than 250° F. In other words, the efficiency is increased threefold, of considerable significance in view of the importance of weight in rockets.—**End**

Table VII: Properties of Dapon M-DAC laminates[a]

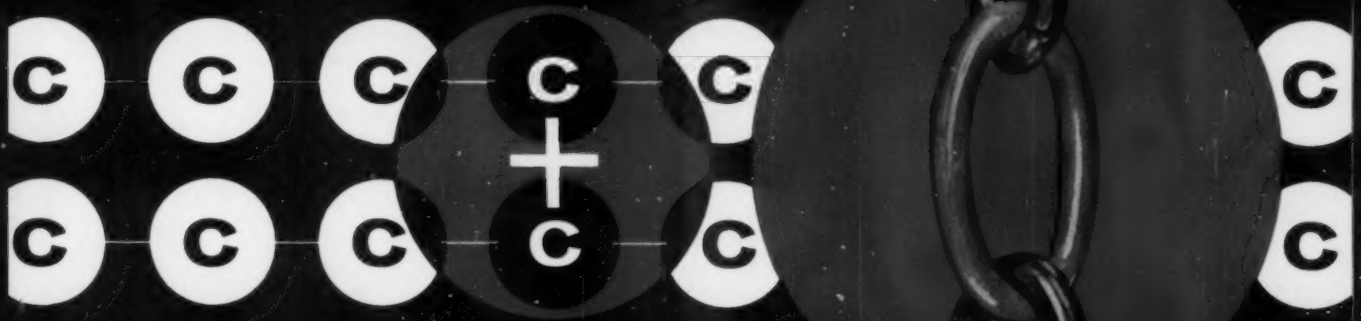
	Dapon M/DAC					
Properties	*100/0*	*80/20*	*80/20 Sb_2O_3*	*60/40*	*40/60*	*20/80*
Flexural strength						
At 73° F., p.s.i.	53,700	56,500	53,800	59,100	67,800	69,600
At 400° F. after 30 min., p.s.i.	43,800	24,200	36,800	34,600	24,700	16,900
At 400° F. after 100 hr., p.s.i.	43,500	24,700	29,700	11,100	5,600	26,200
Flexural modulus of elasticity						
At 73° F., 10^6 p.s.i.	1.53	2.05	1.49	2.12	2.30	2.17
At 400° F. after 30 min., 10^6 p.s.i.	1.70	2.83	2.14	1.49	1.59	1.36
At 400° F. after 100 hr., 10^6 p.s.i.	1.96	1.00	2.46	0.55	0.61	1.44
Burning rate, ASTM D635, in./min.	0.34	NB[b]	NB	NB	NB	NB
Flame out (modified)[c], sec.	Burns	Burns	30	0 to 3	0	0
Wt. loss, 1 hr. at 300° F., %	0.09	0.09	—	0.07	0.06	0.06
Wt. loss, 18 hr. at 300° F., %	0.17	0.21	—	0.14	0.15	0.17
Resin content, %	42.0	46.7	46.0	43.6	42.6	36.0

[a]12-ply laminates, ⅛-in. thick, made with 181 glass cloth, Garan finish. Cured with 2% tert-butyl perbenzoate for 30 min. at 15 p.s.i. and 275° F. and postcured at 300° F. for 1 hour. [b]NB=non-burning. [c]Modified test: ½ by ½ in. vertical bar, 30 sec. ignition time with a Bunsen burner.

Table VIII: Properties of molded nonreinforced allylic resins[a]

	Dapon 35 plus[b]							
Property	*20% DAA*	*10% DAA*	*20% DDG*	*10% DDG*	*20% DAM*	*10% DAM*	*20% MALM*	*10% MALM*
Dielectric constant								
At 60 cy.	3.78	4.12	3.94	4.21	3.58	3.93	3.52	3.50
At 10^3 cy.	3.73	4.06	3.94	4.09	3.52	3.84	3.48	3.45
At 10^6 cy.	3.51	3.79	3.64	3.79	3.36	3.59	3.31	3.32
Dissipation factor × 10^2								
At 60 cy.	1.52	1.71	1.67	2.17	1.33	2.09	1.01	1.19
At 10^3 cy.	1.21	1.53	1.67	2.02	1.11	1.78	0.95	1.04
At 10^6 cy.	1.34	1.42	1.44	1.37	0.94	1.24	1.17	1.07
Loss factor × 10^2								
At 60 cy.	5.75	7.03	6.59	9.14	4.76	8.23	3.57	4.16
At 10^3 cy.	4.35	6.2	6.6	8.25	3.90	6.82	3.32	3.59
At 10^6 cy.	4.70	5.38	5.24	5.19	3.16	4.45	3.87	3.55
Heat distortion temp. at 264 p.s.i., °F.	324	286	288	262	360	307	333	283
Izod impact, ft.-lb./in. notch	0.25	0.27	0.25	0.25	0.24	0.24	0.24	0.22
Rockwell hardness	M114	M114	M113	M112	M119	M115	M118	M116

[a]Cured with 2% tert-butyl perbenzoate for 10 min. at 300° F. and 5000 p.s.i. pressure. [b]Code to abbreviations: DAA—diallyl adipate; DAM—diallyl maleate; DDG—diallyl diglycollate; MALM—dimethallyl maleate.



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Rheology of resinous coating materials

By Donald H. Briggeman*

The rheology of coating materials is necessarily complex. A single viscosity measurement will not sufficiently define the flow properties of a system to insure reproducibility in coating applications. An approach to coating rheology presently being used by our department is described in this article. Expected benefits of this approach are a better understanding of coating properties, more rapid development of new materials, better material specifications, and better process control.

In coating applications we are generally concerned with pseudoplastic fluids, but it is convenient in this field to consider them as apparently plastic materials (Fig. 1, p. 152). Often these materials also exhibit thixotropy, but if displacements from equilibrium are relatively small, this effect may be ignored. Time constants become important if displacements from equilibrium are large.

Figure 2, p. 152, illustrates the stress-flow properties of a pseudoplastic material. If instrument range is limited to the shear rates indicated, the data could be interpreted as indicative of a pseudoplastic or a true plastic, as denoted by the dashed line. Significant deviation from true plasticity occurs only at very low values of shear, at which point apparent viscosity is extremely high. Coating flow in this area would, of course, be practically nondetectable.

For coating applications, therefore, it is often convenient to define flow properties by the apparent yield stress and one other attribute of the straight line representing the flow curve. This other attribute might be the shear stress or the apparent viscosity at some definite shear rate, or it might be the slope of the straight line. It seems reasonable to believe that as shear rates are increased to infinity the apparent viscosity will approach some constant value. We can then define the slope of this line as the viscosity at infinite shear rate. The slope of the flow line, then, may have some physical significance. This approach is justified, of course, only if shear stress—shear rate data within the measurable range lie in a reasonably straight line.

It is suspected that in coating applications the apparent viscosity is related to the amount of material picked up during dipping, and that the yield value is related to the ultimate coating thickness after draining. However, insufficient data are available at this time to make definitive statements.

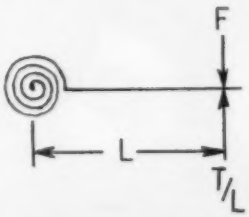
*Specialty Transformer Dept., General Electric Co.

Measurement principles

In this study of coating flow properties, the Brookfield Viscometer has been employed. This instrument is very convenient in studying non-Newtonian fluids because various shear rates, over a limited range, are instantly available. The principle of operation is simple: A spindle, in the form of a cylinder or disk, is rotated in the test fluid through a spring. The deflection of the spring is read on a dial. Dial reading is multiplied by a constant to determine the apparent viscosity. Instruments with four or eight rotational speeds are available. Various models are available with different spring tensions, and each instrument is supplied with a series of spindles to cover a considerable range of apparent viscosities.

The dial indication is actually a measurement of torque. It was desired to express this reading in terms of force per unit area in order to construct shear stress-shear rate diagrams of the type we have discussed. In addition, it was desired to use absolute units in order to correlate data taken with various spindles and with instruments employing springs of different torques.

The following analysis was performed, considering the force balance model of the viscometer:



T = spring torque, dyne-cm.; F = force due to fluid friction, dyne; L = effective moment arm, cm.

In a true plastic fluid the force may be considered to consist of two distinct parts: a) the dynamic, viscous force due to flow, and b) the static force or yield value.

$$F = \frac{T}{L} = F_a + F_b$$

The viscous force can be defined

Table I: Brookfield viscometer data

Model	Spring	Spindle series	Speeds	Viscosity range, from 0 to: Minimum	Maximum
	dyne-cm.		r.p.m.	poise	poise
LVF	673	4	6,12,30,60	1	1,000
LVT	673	4	0.3,0.6,1.5,3,6,12,30,60	1	20,000
RVF	7,187	7	2,4,10,20	5	20,000
RVF-100	7,187	7	10,20,50,100	1	4,000
RVT	7,187	7	0.5,1,2.5,5,10,20,50,100	1	80,000
HAF	14,374	7	1,2,5,10	20	80,000
HAT	14,374	7	0.5,1,2.5,5,10,20,50,100	2	160,000
HBF	57,496	7	1,2,5,10	80	320,000
HBT	57,496	7	0.5,1,2.5,5,10,20,50,100	8	640,000

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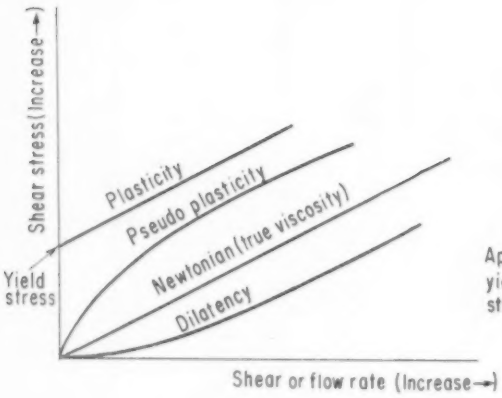

FIG. 1: Various stress-flow relationships.

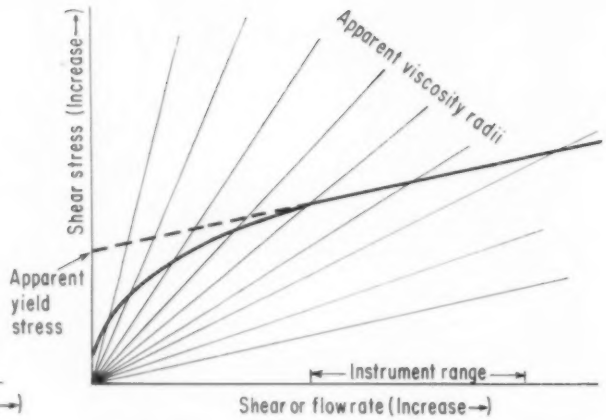

FIG. 2: Stress-flow curve for pseudo-plastic material.

by Newton's equation which, simplified for the rotational viscometer, is:

$$F_s = \eta A \omega C$$

where η = viscosity, dyne sec./cm.^{2} or poise; A = effective area, cm^2.; ω = rotational speed, rev./min.; C = proportionality constant. Then:

$$F = \frac{T}{L} = \eta A \omega C + F_b$$

Dividing through by A and calling the AL product k, the spindle constant, we have:

$$\frac{F}{A} = \frac{T}{k}$$

The spindle constant, k, for a cylindrical spindle is given by the following equation:

$$k = r\,(2\pi r\,h)$$

where k = spindle constant, cm.^{3}; r = cylinder radius, cm.; h = cylinder height, cm.

The smallest spindles in the Brookfield series closely approximate a simple cylinder. Measurements can be made and the spindle constants calculated.

Constants for larger spindles in the series are of non-cylindrical shape. Since their constants are in simple ratio to the smaller, measurable cylinder, all constants can be calculated. Then for any Brookfield instrument:

$$\frac{F}{A} = \frac{T'}{k}\left(\frac{\text{Reading on 100 scale}}{100}\right)$$

where T′ = torque at full deflection, dyne − cm. Data for various instruments and spindles are given in Tables I, p. 150, and II, p. 210.

From spring tension, speed, and spindle data, rheogram charts of shear stress versus shear rate may be prepared (see Fig. 3, left). In addition to absolute units of shear stress in the ordinate, one or more Brookfield scales are usually given. This procedure saves calculation time, and permits use of the charts by non-technical personnel.

A Newtonian fluid can be defined by a single datum point; its rheogram curve will coincide with one of the viscosity radii and will pass through the origin. The non-Newtonian fluid requires more than one datum point to define its curve; its curve may not pass through the origin, but its curve will intersect several viscosity **(To page 210)**

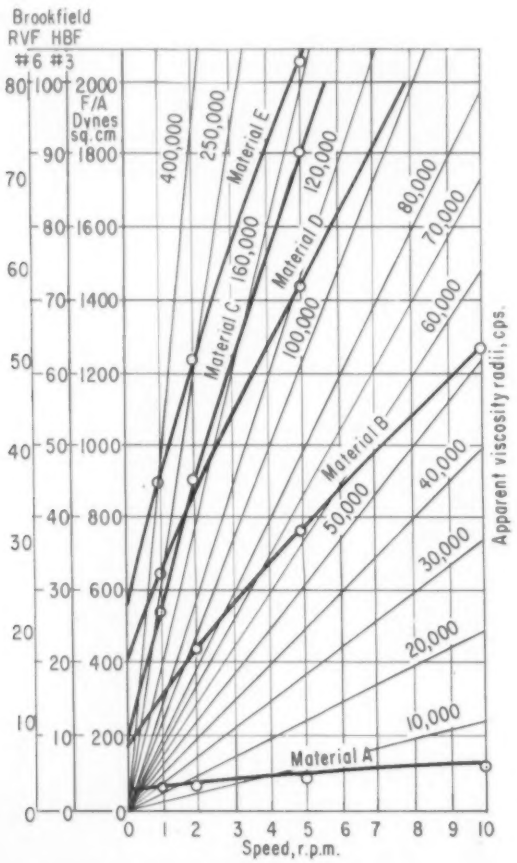

FIG. 3: Rheogram of coating materials.

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Let's not price

(*From pp. 96-97*)

product in terms of raw material cost/lb., a most disastrous decision could be made in selecting ABS II.

If, as in Section B of Table V, we figure the gross return per 100 ft. of pipe, the picture changes completely. It is now obvious that ABS II at 1800 is not the most profitable selection.

It should be noted too that the differences in working fiber stresses and raw materials prices used in the analysis in Table V represents an explosive competitive situation inasmuch as we have assumed a constant selling price. If the extruder looking for business, and willing to be satisfied with a lower rate of return, started out to cut prices in PVC I, ABS II at 1800, and ABS IA at 1500, he would set off a round of price drops comparable to that experienced in the polyethylene field.

PVC and ABS are both resins with enormous potential growth. The use of these materials provide pipe of excellent quality when produced with a working fibre stress of sufficient safety. If, however, the fibre stress values are used as competitive weapons to provide pipe at a price—and upon price alone—then the manufacturers of such resins and the extruders who follow this practice certainly are doing an injustice to the consumer; and, equally important, to the future of plastics as piping material.

In the case of ABS II material, a recommendation of the resin supplier of a *maximum* working fibre stress accompanied by the factor of safety to use and a guarantee by him of performance of such material would at least set a basic limit to the material. The same, if done in PVC I, would help stabilize the limits of this material.

With this done, competition *could* center upon the selective merits of each material assuming the extruders did not in their own unstable fashion make a football out of prices.

The recent price cuts in ABS I and now in PVC are attempts by the resin manufacturers to equate their materials.

In the final analysis, for the extruder to receive the same gross profit (*e.g.*, $0.740/lb. as in ABS II at 1800), the raw material cost in relationship to the weight per 100 ft. would have to be as shown in Section C of Table V. It can be seen from this that with the recent price drop in ABS materials, only ABS IA comes close to matching PVC I price in terms of gross profit per pound of raw material processed. This, however, assumes that the manufacturer will guarantee and the extruder accept a working fiber stress of 1500.

In meeting competition, when we sell by the foot, but the cost and price are by the pound, it can be seen that any major change in material composition which affects weight without a compensating change in price of finished goods or cost of raw materials could upset the economic balance. Failure to carefully consider all these factors could result in pricing yourself into oblivion.—**End**

Table III: 100-lb. SWP, sleeves attached, dollar return/lb. of resin.

Size	ABS I		ABS II	
	Price/100 ft. (sleeved)	Ret./lb.	Price/100 ft. (sleeved)	Ret./lb.
	$	$	$	$
2	32.50	1.07	31.03	1.29
2½	42.47	1.08	37.48	1.10
3	67.00	1.06	51.05	1.10
4	106.15	1.04	78.69	1.10
6	245.25	1.02	171.82	1.10

Table IV: Weight and price reduction of ABS II vs. ABS I 100-lb. SWP

Size	Reduction weight	Reduction price
	%	%
2	21.3	4.5
2½	21.3	11.7
3	34.3	23.5
4	36.9	26.0
6	39.6	42.0

Based on a fiber stress ABS I—1200; based on a fiber stress ABS II—2000; 1958 weight and price percentages.

Table V: Comparisons of gross profits return on 1½-in. pipe by various materials, plus indicated prices for each material to achieve equal gross profit on all

Material	Working fiber stress	Per 100 ft. Wt./lb.	Per 100 ft. Selling price	Per lb. Selling price	Per lb. Raw material	Gross profit	Gross profit 100 ft.	Same gross profit raw mat. cost lb.
	p.s.i.		$	$	$	$/lb.	$	¢
PVC II	1200	26.75	19.35	0.723	0.33	0.393	105.13	0.280
PVC I	1700	19.87	19.35	0.970	0.36	0.610	120.21	0.375
ABS II	1700	15.58	19.35	1.240	0.60	0.640	99.71	0.480
ABS II	1800	14.42	19.35	1.340	0.60	0.740	106.71	0.520
ABS I	1200	20.99	19.35	0.920	0.49	0.430	90.26	0.356
ABS IA	1500	16.86	19.35	1.140	0.49	0.650	109.20	0.470
			A				B	C

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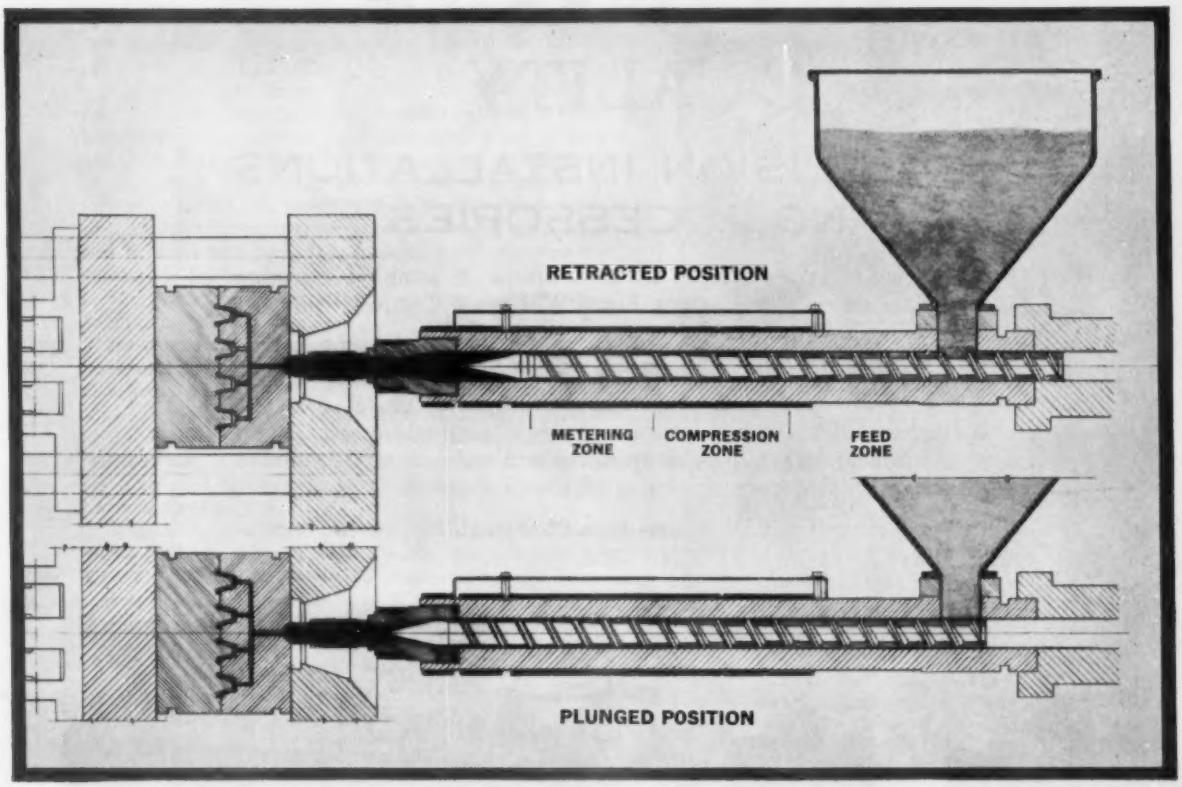

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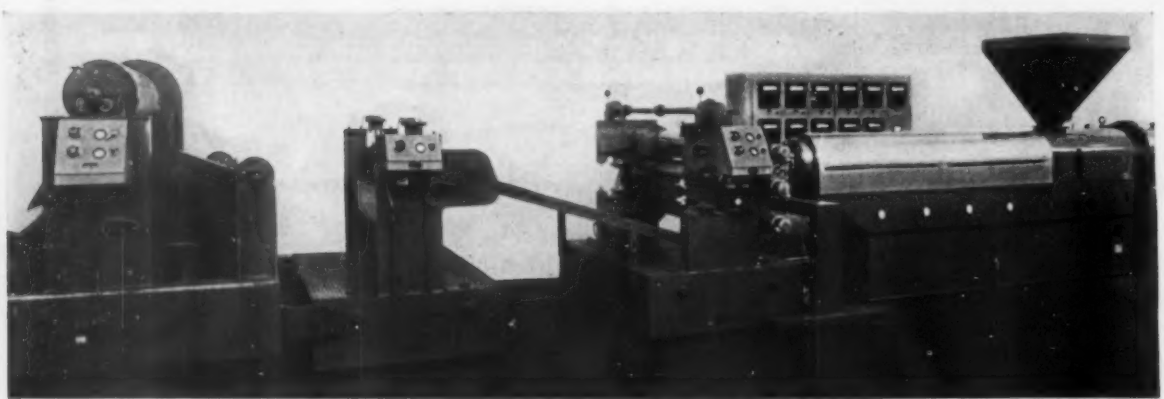
Egan Extruders are available in sizes from 2" through 12", vented or non-vented, with L/D ratios of 20:1, 24:1, 32:1.



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NEW DEVELOPMENTS

Many minds at work on new ways to use plastics, new designs, and new product concepts offer ideas you can use.

RP molds for concrete casting

Reinforced polyester molds have been successfully used by two Minnesota companies in a new method for casting pre-stressed concrete beams.

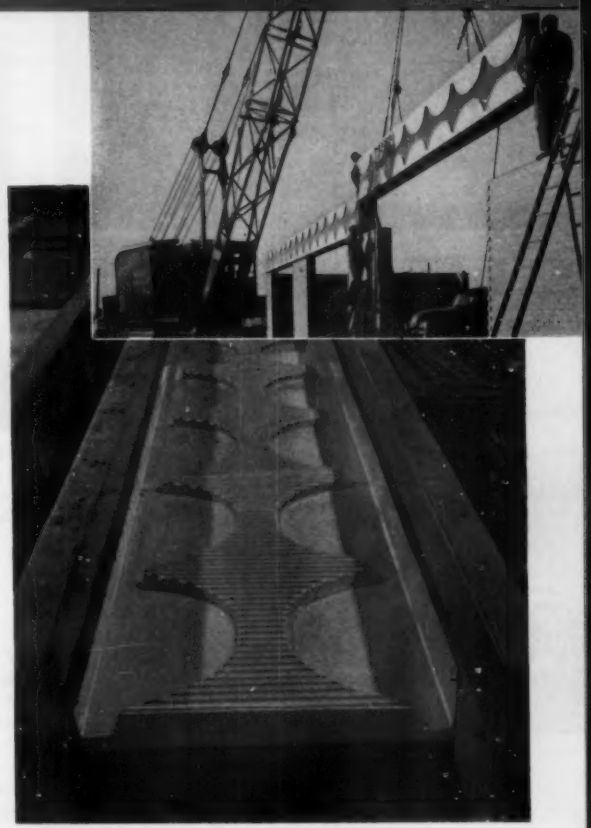
The molds were made in sections by gun-spraying a polyester-glass formulation onto wooden patterns. Sections were then sealed together by further application of resin and glass, making it possible to form seamless casting molds in any length. With wood and other sheet molds, seams cannot be hidden and mold length is limited. Development of a special gel coat overcame the problem of surface pits and cracks, which could have caused imperfections on the face of the finished beams.

The finished molds are securely anchored to steel pallets prior to casting.

Prestressed concrete beams cast by the new method can have both decorative and structural functions. As used in a recently erected Midwest school building, 28-ft. beams span all wall openings and support the roof. Only two reinforced plastics molds were utilized for the entire construction job; if wooden molds had been used, they would have required replacement after approximately every two or three castings.

Because the RP molds permit virtually unlimited possibilities in beam size and shape, surface texture, and design, they are expected to be adapted to the casting of columns, panels, blocks, and possibly even to complex domes, folded plate roofs, and other structural sections normally consisting of irregular surface.

The RP molds were built by Resco Inc., Victoria, Minn., using Q-6009 isophthalic resin that was purchased from Archer-Daniels-Midland, Minneapolis, Minn. Concrete beams for the school construction were designed by Matson & Wegleitner, architects, and cast by Prestressed Concrete Inc., St. Paul, Minn.



REINFORCED POLYESTER mold, shown in close-up immediately above, can be used to make pre-stressed concrete castings of any length without visible surface seams. Top photo shows decorative panel made in mold being set in place on site.

Phenolic upgrades cotton

Using phenolic resins as the binding agent, Lockport Mills, Lockport, N. Y., a manufacturer of cotton and wool products for use in furniture and bedding, has been able to promote second-grade cotton to first-grade. The resin is supplied by Durez Plastics Div., Hooker Chemical Corp., Niagara Falls, N. Y.

Lockport is using the resin as a bonding medium in FlexFil, a material employed primarily in upholstery and padding applications. The company found that certain suitable grades of cotton were being disposed of as second-grade material by cotton manufacturers. Research by the company indicated that cotton in this category can be sufficiently upgraded and strengthened by a bonding medium. Tests reported by the company indicate that FlexFil subjected to 200-lb. pressure for 48 hr. and to 100,000 compressions showed better density and resilience than similar materials, without being corrosive or allergenic.

Durez states that its resin was selected because it imparts strength, durability, and resilience to the basic material. It also permits manufacturing economies and increased production while maintaining product quality. The over-all production saving was more than one-third greater than savings possible with other resins, according to company reports.

Typewriter cover with integral hinge

The remarkable flexing properties of molded polypropylene are finding increasing recognition in a growing number of design areas where the economies of a low-cost integral hinge might be called for. Latest case in point is the carrying case for the Tom Thumb toy typewriter: The cover, base, and integral hinge are all molded as a single unit, eliminating the need for conventional metal hinging parts. According to the manufacturer, the cover may be opened and closed thousands of times without the hinge cracking or tearing.

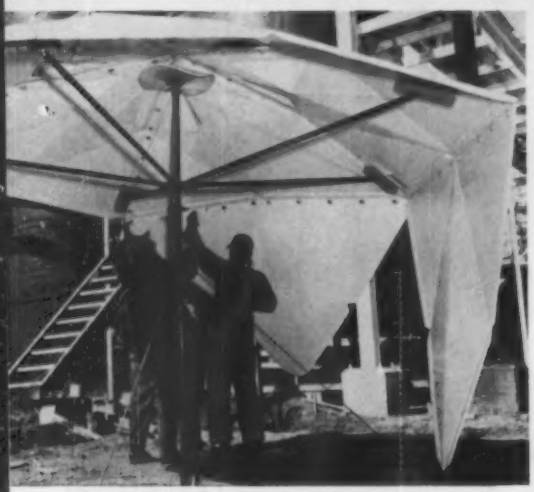
The typewriter itself incorporates other plastics components: key tops, spacer bar, and platen knobs are acetate.

Typewriter and case are manufactured by Western Stamping Co., Jackson, Mich. Polypropylene for the cover is supplied by Eastman Chemical Products Inc.

(More on page 158)

COMPLETED SHELTER encloses 3000 cu. ft., offers 352 sq. ft. of floor space. Construction cost is 10¢ per cu. ft., and erection time is said to be less than one day.

FIRST STEP in erecting utility shelter is to bolt together triangular panels. These panels, consisting of polystyrene foam core and kraft paper skins, will form top section of shelter. Notice air vents (center) pre-scored in panels.



TOP SECTION is elevated and held in place by metal mast, extensions, and ropes to permit addition of side panels. Mast and other supporting parts are removed from the completed shelter, since the geodesic design makes it a self-supporting structure.

Polystyrene foam-kraft sandwich structure, at 10¢/cu. ft., erected in less than one day

Utility shelters that are said to cost less than $1 per sq. ft. and roughly 10¢ per cu. ft. can be quickly erected from sandwich panels consisting of kraft paper skins and rigid polystyrene foam core.

The shelter is designed for such outdoor uses as storage space for construction, agriculture, or military equipment; field service facilities for first aid stations or disaster relief agencies; and temporary mobile housing for military, scientific, mining, and surveying personnel. The novel shelters are also recommended for summer camping use.

A finished shelter has a diameter of 21.2 ft. and is 12½ ft. high at its center. This provides an interior volume of 3000 cu. ft., and 352 sq. ft. of usable floor space. The shipping weight for a completed utility shelter is 500 pounds.

For a base price of $345, the user receives all components necessary for raising a shelter, including 45 triangular paper-plastic panels in five different sizes; a wooden base ring; rectangular door panels; caulking compound; aluminum bolts, nuts, and washers; and a metal erection mast. The latter part is rented for a $25 deposit; since the mast is unnecessary in a completed shelter, the user returns it to the seller for refund of his deposit.

Each panel consists of 69-lb. kraft paper stock laminated to both sides of a ½-in. rigid polystyrene foam core. The foam is a closed cell type, and has a density of 2 lb. per cubic foot. The panels are bolted together, starting with the top sections, and the mast is then used to raise these top sections and hold them in position for addition of the lower sections. Bottom sections are bolted to the wooden base ring, which is specially treated for protection against fungus and termites. It is said that two men can erect one of these shelters in less than one day. Pre-scored vents in panels for the upper half of the shelter can be opened or closed as desired, while panel sections may be left unbolted and propped open to provide window areas. The geodesic type of construction permits distribution of stress load throughout the entire dome, and it will withstand strong winds, rain, and heavy snows. For added weather resistance, each panel is dip-coated with an alkyd-type paint in a choice of yellow, green, or white color.

Construction is said to be so strong that a shelter unit can be relocated without disassembly, simply by removing ground stakes, carrying the shelter to a new site, and re-staking down the base ring.

Panels are supplied by Fome-Cor Corp., Springfield, Mass. The shelters, tradenamed Geospace Dome Shelters, are produced by Filtered Resin Products Co., Baxley, Ga., a subsidiary of Monsanto Chemical Co.

First plastic housing for Canadian typewriter

A Canadian typewriter company has switched from metal to plastic for the housing of its product, a switch similar to that instituted by a major American manufacturer last year—and once again acrylonitrile-butadiene-styrene (ABS) has been the material selected (see "The plastics typewriter—a big step forward!" MPI, May 1960, p. 92).

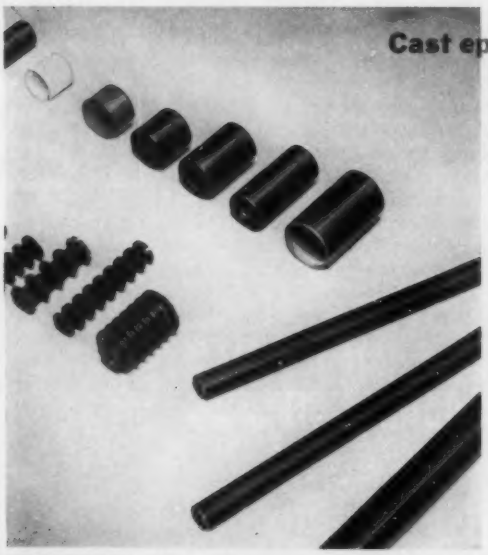
By specifying ABS for both the main frame and ribbon cover of its Model 650 machine, Commodore Portable Typewriter Co., Toronto, has reduced unit weight from the 17½ oz. of a former metal-housed typewriter to just 10½ oz.—and without sacrificing either structural strength or stability.

The two molded ABS parts form a scratch- and corrosion-resistant housing that will not chip, crack, or break in normal use, will not bend or warp under impact, and will resist ink, type cleaners, and carbon paper smudges. The plastic housing also offers integral color and a surface that is warm to the touch.

Molder of the two housing components is Canadian General Electric Co., Cobourg, Ontario. Molding material is Cycolac, which is a product of Marbon Chemical Division of Borg-Warner Corp.

ABS is used for main frame and ribbon cover of this Canadian typewriter. Switch to plastics provides integral color, scratch-free surface, lowers weight of instrument.

Cast epoxy rod for machining into electronic parts



ELECTRONIC parts shown were machined from epoxy rods of type shown to right. Rods come in 14 standard diameters from ¼ to 1 in., are available unfilled or with fillings of slate, talc, silica, or mica.

A new line of cast epoxy rod, which is designed for machining into electronic winding forms, is distinguished by high volume resistivity at elevated temperatures as well as high heat distortion.

The material, available from Boonton Molding Co., Boonton, N. J., is formulated to meet such rigid specifications as MIL-R-93B for precision wire-wound resistors. Another use foreseen is in thin-wall shells for potting coils, with application fields in computers, missiles, and aircraft.

Volume resistivity of the cast epoxy rod, according to Boonton, has been tested out at 0.19×10^{16} at 180° C., and heat distortion temperature at 272° F. at 264 p.s.i. The rod is said to be economically machinable by conventional shop techniques, and machined parts reportedly maintain excellent dimensional stability.

The rod is supplied in seven colors and in 14 standard diameters ranging from ¼ to 1 inch. Rod lengths available range from 46 to 48 inches. The rod is sold with various percentages of slate, talc, silica, or mica fillers, or it is also available in its unfilled state.

Price per pound varies depending upon filler content—as this goes up, prices go down—but, generally speaking, per-foot costs of this cast epoxy rod, with any filler percentage, range from approximately $0.188 for the ¼-in. to about $0.919 for the 1-in. rod.

Butyrate houses new checkwriter

The molded butyrate housing of a lightweight, moderately priced checkwriting machine is ample evidence that the recent trend to plastics housings for all types of office equipment is not confined to the larger and more expensive units.

Priced to retail at $18.95, this versatile plastic equipment, which is tradenamed Sumit Checkwriter, is designed to fit the budgets of users in smaller commercial establishments and in the home, although it is also said to be suitable for use by large business firms.

Butyrate was selected because of its toughness and resilience, coupled with low weight. Total weight of the unit is 4 pounds.

The housing consists of three parts: two side panels and a center dome section. All are injection molded in clear butyrate in a 3-cavity mold on an 8-oz. Reed-Prentice machine. The clear parts are then painted from the underside in a blue color and bolted to an inner metal frame.

The machine is manufactured by Pearl Engraving Corp., New York City. Molder is Astor Tool & Die Co., Brooklyn, N. Y., which uses Tenite material from Eastman Chemical Products Inc.

(More on page 160)

BUTYRATE was used for housing of desk-top checkwriter because it combined light weight and toughness.

Rigid PVC for home appliance parts

Can you use reciprocating-screw injection machines for the production of rigid PVC appliance parts? According to tests conducted at the demonstration laboratories of Buhler Bros. Engineering Works, Uzwil, Switzerland, the answer is an emphatic, Yes!

The machine used in these tests was a Buhler Rover 350 injection machine, with a clamp force of 350 tons and a shot capacity of 32 ounces. The material being molded in the tests was Rhovilite AX, a polyvinyl chloride acetate copolymer made by Rhone-Poulenc, France. This material is said to offer nonflammability, good chemical resistance, impact strength, and excellent surface appearance; and has been suggested by Rotel Household Appliances, Switzerland, to its custom molders as a resin that might be suitable for molded household appliance housing components. Heretofore, most of these parts have been made of styrene copolymer.

One test was conducted on a mold producing a 32-oz. shot. The product in this case was a Rotel kitchen appliance stand and base plate (see Fig. 1), the machine was the Rover 350 and the material Rhovilite AX. Projected area of both stand and base plate was 100 sq. in. each. Cycle time was 70 seconds. According to Buhler, "the result was perfect," although the 32-oz. shot was at maximum machine capacity.

The molding machine used was a standard model, with the injection cylinder and screw, selected for work with PVC. No material decomposition was reported, in contrast to several conventional plunger machines on which Buhler had run tests previously. Figure 2 shows a Rotel mixer base molded of white Rhovilite AX with a cycle time of about 60 seconds. According to Buhler, this is about the same as for styrene copolymer material molded on a conventional plunger-type machine, as reported by Riwisa Plastics Works, Switzerland, owners of the mold. The mold was chrome-plated for the test.

When molding PVC, Buhler recommends that the machine be heated up and the molding started with a less heat-sensitive material than PVC. In this test, red polyethylene was used. The company found that it takes just four shots to change from red PE to white PVC. As shown in Fig. 2, Shot 2 (second from left) is still divided into red and white portions. With the third shot, only minor traces of red are left (at the gate area). Shot 4 and subsequent pieces were white.

FIG. 1: Stand and base plate

FIG. 2: Four-shot purging.

Molded RP case for hand dryer

Matched-die molding of polyester-fibrous glass preforms, used to produce the housing of a new electric hand dryer, is preferred to metalworking methods because of lower tooling cost, better heat and electrical insulation, less weight, higher impact resistance, and greater design latitude.

According to the manufacturer, Jet Hand Dryer Inc., Los Angeles, Calif., tooling costs for metal construction would have been several times those for preform molding. The integral coloring of the reinforced plastics case eliminates painting costs; contours impossible to achieve in metal are designed into the case at no extra cost. Also, shipping rates are lower with the 2½-lb. reinforced plastics case, which would have weighed approximately 5½ lb. if it had been made of metal.

The housing for the hand dryer is made by Plastic Age Co., Saugus, Calif., which also manufactured the automatic preforming equipment and the 150-ton hydraulic molding press. The preforms are made by the directed fiber method, in which fibers cut from glass roving are blown through a flexible hose onto a preform screen. Each preform charge is then molded in a polished tool-steel die, constructed with shear edges to trim off the molded part.

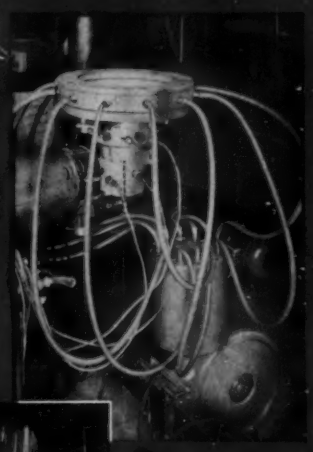
Only one finishing operation is needed on the molded case—routing of a hot-air outlet snout. The case is then fitted with an advertising window consisting of a lithographed transparency sandwiched between acrylic sheets, a clear outer layer, and an opaque inner layer which diffuses light through the picture to give it a three-dimensional effect. The acrylic sheets not only afford an aesthetic frame for the ad, but also protect it from breakage.

Flame-resistant polyester resin is specially compounded for this application by Hooker Chemical Corp.; glass roving is supplied by Owens-Corning Fiberglas Corp.; and acrylic sheeting by Rohm & Haas Co.

HOUSING of polyester-fibrous glass preforms, molded on matched dies, weighs 3 lb. less than metal housing, eliminates finishing and painting costs.

(More on page 162)

For highest quality blown film, or cast film by the chill-roll method



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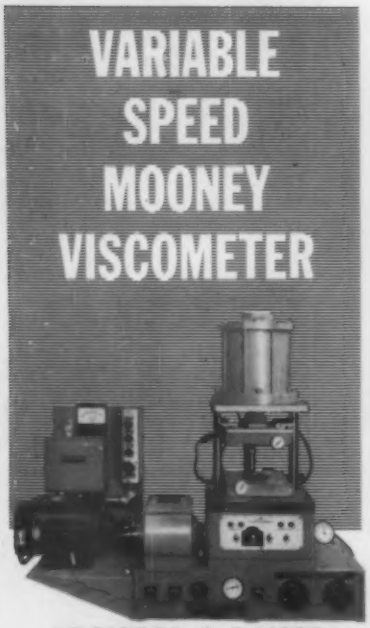

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Write today for full details on the Variable Speed Model STI. Scott Testers, Inc., 96 Blackstone St., Providence, Rhode Island. Tel.: DExter 1-5650 (Area Code 401).

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PS housing for radio-phonograph

A high-heat, high-impact polystyrene housing protects a new portable radio-phonograph from two problems often encountered during use—damage to working parts that is caused by rough handling and distortion or weakening of the housing from extreme heat conditions.

The complete housing is made up of a bottom section, which encases the transistor-powered motor, and a top cover, which fits over the phonograph turntable and pickup arm and also over the radio operating controls. Contrasting molded-in colors are light blue for the bottom section and navy blue for the top cover. Other plastic parts are: phenolic for the turntable; impact polystyrene for the pickup arm; general-purpose crystal polystyrene for dials; and metallized vinyl for the escutcheon plates on the front cover and on the carrying handle.

The radio-phonograph combination is marketed by Bell Products Co., St. Louis, Mo. It weighs just 5 lb., measures 11 by 7 by 3¾ in., and retails for $54.95. Housing components are injection molded by Cepco Plastics Co., St. Louis, using Styron 440 (Dow Chemical Co.) material.

TWO-PART housing is molded in two colors of polystyrene, provides protection to working parts, and it is also resistant to extreme heat conditions.

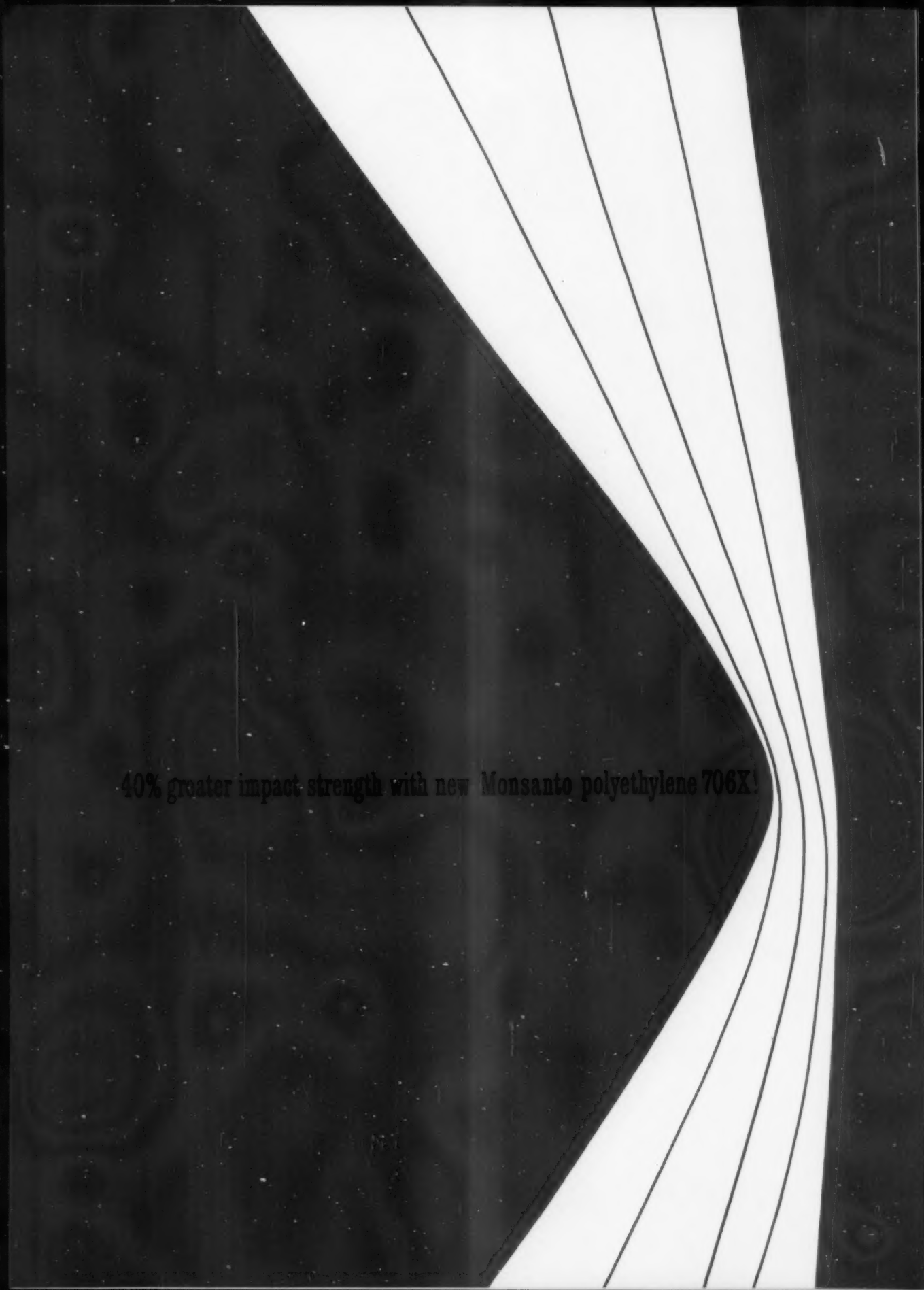
New shape for nylon sweeper bristles

It is a measure of the importance of the street sweeper market that Du Pont has introduced a nylon monofilament just for this application. The company has serviced this field in the past with a Tynex bristle, extruded of nylon 6/10, selling at around $2.50 per pound. Now, under the tradename Herox, it is offering a nylon 6/6 bristle to sell at an introductory price of $2/lb. in 1000-lb. lots. The monofilament is extruded at the company's Parkersburg, W. Va., plant in the shape of an I-beam. The exact dimensions are 105 mils in the long direction, 90 mils in the short direction, and 55 mils across the web.

According to Du Pont, this construction offers a degree of stiffness to the fiber that makes it particularly suitable in this application. At the same time, the company states, about 20% fewer filaments are needed to fill a broom with the I-beam construction than with round fibers, amounting to a saving of 30 to 40 lb. per broom. Several test brooms are now running in such locations as New York, N. Y.; Miami, Fla.; St. Louis, Mo.; and other locales where special attention will be paid to the effect of moisture on the performance of the bristles. Lab tests reported by Du Pont claim exceptional stiffness and efficiency. Whether the same values will be obtained in the field remains to be seen.

Solid plastic furniture board

A solid laminate board that is said not to separate, delaminate, or warp because of its structural homogeneity, has been introduced by Northern Plastics Corp., La Crosse, Wis. Expected applications are in hotel and institutional furniture, **(To page 165)**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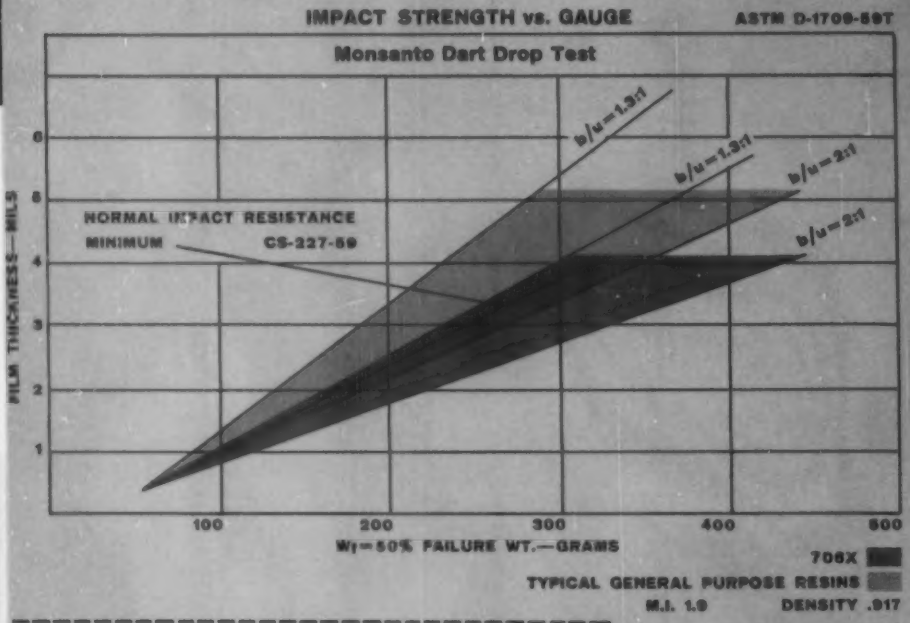

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schoolroom desk and table tops, and hospital equipment.

From top to bottom, the board is comprised of: a melamine overlay sheet; melamine-coated decorative sheet; phenolic-coated paper; a resin-impregnated wood fibre core; another phenolic-paper layer; and a melamine underlay sheet. These six layers are laminated into one solid mass under extreme heat and 1000-p.s.i. pressure. The fused product is structurally rigid and requires no backing.

According to the manufacturer, the board is 50% harder than solid hickory and has the screw-holding properties of birch. It is cigarette-proof and resists heat, abrasion, staining, and chipping. Edges can be shaped in the same manner as wood, and can also be stained, lacquered, and finished to match the board face.

The board, known as Norplex, is supplied as 4- by 8-ft. panels in 5/8- and 13/16-in. thicknesses and is available in many decorative or natural wood surface patterns.

Versatile PE containers

Unbreakable, non-corrosive, and lightweight containers, designed for safe carrying of regular and "problem" liquids, are blow molded of Scepterene, a linear polyethylene specially compounded with additives for maximum resistance to migration of liquid contents.

Gasoline, kerosene, naphtha, oil, water, solvents, inks, acids, drugs, and heavy detergents are among the liquids that can be transported in the new containers. They are available in 1- or 2½-gal. sizes (5- and 11-qt. capacities respectively), with adequate headspace for normal expansion of contents and the addition of motor oil when necessary.

The Jerry Jugs are molded and marketed by Dillon-Beck Mfg. Co., Hillside, N. J., U. S. licensee for the Scepterene compound, a product of Scepter Mfg. Co., Toronto, Canada.

The 1-gal. jug weighs approximately 1 lb., and is priced at $2.49. The 2½-gal. model weighs about 2 lb. and costs $3.49. A molded PE pouring spout, which can be stored inside the jug when not in use, a spout cap, and a screw cap, are supplied with each container. A finger grip, integrally molded into the bottom of the containers, aids in tilting and pouring. Colors available are red, white, and yellow.

A 5-gal. Blow-O-Matic blow molding machine, made by Danish Plastics, Copenhagen, Denmark, is teamed with a Bandera extruder to produce the containers. This equipment is distributed in the U. S. by the Rainville Co. Inc.—End

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LITERATURE

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"Plastics Tooling—Second Edition," *by Malcolm W. Riley.*

Published in 1961 by the Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. 216 pages. Price: $7.50.

A complete revision of the first edition on the properties of the materials and fabricating methods used to build plastic tools. New materials and methods such as metal-fiber reinforced epoxies and the gas or electroless plating of plastic tools are described. Extent of use of the various techniques and other data dealing with the evaluation of new developments is included. An excellent, up-to-date summary on the subject—*G.R.S.*

"Polymeric Materials," *by Charles C. Winding and Gordon D. Hiatt.*

Published in 1961 by the McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y., 406 pages. Price: $12.00.

Designed for the engineer who requires a basic grounding in the field of polymeric materials, this book surveys the entire subject and is meant to serve as a springboard into more advanced study in the fields of particular interest to the engineer. Included in the book are discussions of the basic chemistry of polymerization, properties of polymers, applications and processing, natural polymers, condensation and ethenic polymers, silicones, and rubber. At the end of each chapter an adequate list of references is included to guide the reader to more advanced treatments of the subject covered in the chapter and further study. An excellent first text for future plastics engineers with a basic knowledge of chemistry—*G.R.S.*

Plasticizers. Description, compatibility, specifications, physical properties, applications, dermatology and toxicology, handling, etc., for using Arocolor compounds as fortifying extenders and plasticizers in PVC, PVAc, epoxies, polyesters, PE, polystyrene, polyurethanes, phenolics, ethyl cellulose, nitrocellulose, cellulose acetate butyrate, and other resins. Over 100 formulations given. 49 pages. *Organic Chemicals Div., Monsanto Chemical Co., 800 N. Lindbergh Blvd., St. Louis 66, Mo.*

Epoxy resins. "Epoxy Casting and Adhesive Resins of Adjustable Flexibility" describes the typical properties of cured flexible systems, type of hardener to be used, directions for using Isochemstrip 701 and 708, etc. Sample kits containing 1 pt. each of Safety Gel, Isochemstrip 701 and 708, and Isochemterges 1401 and 1405 for experimental purposes available for $13. 2 pages. *Isochem Resins Co., 221 Oak St., Providence 9, R. I.*

Dry coloring. Advantages, uses, colors available, and general information on the dustless dry coloring of impact polystyrene, polyethylene, and polypropylene. 3 pages. *Color Division, Ferro Corp., 4150 East 56th St., Cleveland 5, Ohio.*

Printing and decorating polyethylene. Illustrated with schematic diagrams, booklet compares principles of hot stamping, flexography, gravure, offset lithography, silk screening, transfer labeling, and four-color dry offset lithography. Includes printing speeds; plate making; ink coverage; and cost of equipment, plates, and ink. Also gives 250 sources for services, equipment, and supplies described. 16 pages. *Polymer Chemicals Div., W. R. Grace & Co., 225 Allwood Rd., Clifton, N. J.*

Temperature controls. Descriptions, specifications, and uses for 17 types of temperature controls, detectors, and indicators. Bulletin MC-203. 8 pages. *Fenwal Inc., Ashland, Mass.*

Mold releases. "Buyers Guide to Silicone and Other Mold Releases" lists prices for all types of IMS parting agents from the 9 oz. can to 44 oz. size. Also includes data on silicone type greases, rust preventatives, etc. 16 pages. *Injection Molders Supply Co. Inc., 17601 S. Miles Rd., Cleveland 28, Ohio.*

Polypropylene film. Properties, chemical resistance, electrical characteristics, printing considerations, applications, etc., for Olefane polypropylene film. Includes samples. 8 pages. *Avi-Sun Corp., 1345 Chestnut St., Philadelphia 7, Pa.*

Motors, gearmotors. Specifications, models available, and uses for a line of a.c. and d.c. motors and gearmotors for the plastics and other industries. Bulletin 2651. 8 pages. *The Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis.*

Nylon. Properties and applications for MC Nylon formulation. Also lists mill shapes available. Bulletin MC-2. 4 pages. *The Polymer Corp., Reading, Pa.*

Copper-clad laminates. Material, characteristics, properties, heat resistance, etc., for Grades XXP-E and XXP-R copper-clad paper-phenolic laminated plastics. Bulletin 3.1.20. 2 pages. *Taylor Fibre Co., Norristown, Pa.*

Commercial standard for PVC pipe. Revised standard, designated Rigid Unplasticized Polyvinyl Chloride Pipe, CS207-60, provides requirements and methods for test for materials, dimensions, workmanship, chemical resistance, brittleness, and minimum burst pressure for two types of PVC pipe. Price: 10 cents. *Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C.*

Polyesters. "New High Strength Vibrin 160-B for Hand Lay-Up Laminating" outlines special features, properties, approximate gel times, etc., for this room temperature laminating polyester resin. 4 pages. *Naugatuck Chemical, U. S. Rubber Co., Naugatuck, Conn.*

New Developments in Vacuum Metallizing describes metallizing coatings systems which may be applied by spraying, dipping, or flow coating to thermoplastics, thermosetting compounds, metals, and glass. 4 pages. *Bee Chemical Co., 2700 E. 170th St., Lansing, Ill.*

Fluorocarbon resins. Development history; general, electrical, mechanical, thermal, and chemical properties; special design considerations; applications; etc., for Teflon fluorocarbon resins for electrical and electronic systems. 20 pages. *Polychemicals Dept., E. I. du Pont de Nemours & Co. Inc., Wilmington 98, Del.*

Automatic temperature controls. Bulletin discusses the how and why of automatic temperature control in injection molding, vacuum forming, blow molding, film extrusion, and film laminating. Bulletin 1070. 6 pages. *Sarco Co. Inc., 635 Madison Ave., New York 22, N. Y.*

PE, acetate, and cellulosics. Properties and uses for Tenite Polyethylene 895-P-60000 Natural, a low-density resin for extrusion-coating of paper and other substrates. **(To page 168)**

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Materials Bulletin 2. 3 pages. Similar data for Series 3300 and 3400 high-density Tenite PE. Materials Bulletin 3. 3 pages. Properties and extrusion data on Tenite PE pipe-grade formulations. Materials Bulletin 8. 2 pages. "Tenite Cellulosic Plastics" outlines properties, versatility, and uses for Tenite acetate, butyrate, and propionate. 8 pages. Typical extrusion conditions and properties for Tenite Acetate Formula 081, an acetate composition for producing sheet for vacuum forming. Materials Bulletin 7. 2 pages. *Eastman Chemical Products Inc., Kingsport, Tenn.*

Epoxy resins. Two bulletins, 1 page each, describe Maraset unfilled epoxy casting powder No. 135E and filled powder No. 136E, developed for encapsulating and impregnating transformers, coil windings, and other electrical and electronic components and equipment. Includes step-by-step working instructions. Working samples of either resin available from the company for $4 per quart. *Marblette Corp., 37-31 Thirtieth St., Long Island City 1, N. Y.*

Pressure indicator. Specifications, prices, description, uses, etc., for Teledyne Model 236 pressure indicator, designed for the remote indication of gas pressure, fluid pressure, thrust, and torque in extrusion molding. 2 pages. *Taber Instrument Corp., North Tonawanda, N. Y.*

Acrylic monomers. "Storage and Handling of Dow Badische Acrylic Monomers" discusses the handling of that company's ethyl, methyl, butyl, and 2-ethylhexyl acrylates. 18 pages. *The Dow Chemical Co., Midland, Mich.*

Weight sensing systems. Manual shows how the principle of weight sensing—or measurement of force—can be utilized to perform a variety of production and quality control functions in the plastics and other industries. 8 pages. *The Exact Weight Scale Co., 920 W. 5th Ave., Columbus 15, Ohio.*

Adhesives; corrosion. Eight selective bibliographies, listing the latest government research reports and other technical documents available to science and industry, have been published by OTS. *Corrosion* (10-yr. bibliography), 10 cents. *Adhesives* (Supplement to CTR-300), 10 cents. *OTS, Department of Commerce, Washington 25, D. C.*

Plastics—the Story of an Industry is the 9th revised edition of this familiar publication, which presents in layman's language the growth, history, and make-up of the plastics industry, including uses, properties, types and forms and methods of molding 22 plastic materials; discussion on the various processing techniques; list of American colleges and universities offering courses in plastics; etc. 42 pages. Prices: 1 copy (complimentary); 2 to 49 copies (30¢ each); 50 to 499 copies (28¢ each); etc. *The Society of the Plastics Industry Inc., 250 Park Ave., New York 17, N. Y.*

Spray decorating, wiping machines. Specifications and features for Model 2GOR automatic dial spray decorating machine. Similar data for Model DW2D air operated wiper, which measures 36 by 18 in. and 36 in. high. Additional information for Model DW24RT automatic rotary wiping machine, which reportedly wipes from 700 to 3600 pieces per hour. 2 pages. *Conforming Matrix Corp., Toledo Factories Building, Toledo 2, Ohio.*

Marking and numbering machines. Types, sizes, uses, and similar data for a line of marking and numbering machines for the plastics and other industries. Includes supplementary data on stamps, dies, foils, inks, etc. 14

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pages. *AcroMark Co., 9-13 Morrell St., Elizabeth 4, N. J.*

Polyethylene glycols. Physical properties, applications, solubilities, specification limits, test methods, toxicological properties, and other technical data for Carbowax polyethylene glycols, which are used, among other things, as intermediates in the manufacture of alkyd, methacrylate, polyurethane and other resins. Selected bibliography. 66 pages. *Union Carbide Chemicals Co., 270 Park Ave., New York 17, N. Y.*

Masks. Bulletin illustrates the various types of masks used in the multiple color wet painting of plastics products. 4 pages. *Conforming Matrix Corp., 830 New York Ave., Toledo 11, Ohio.*

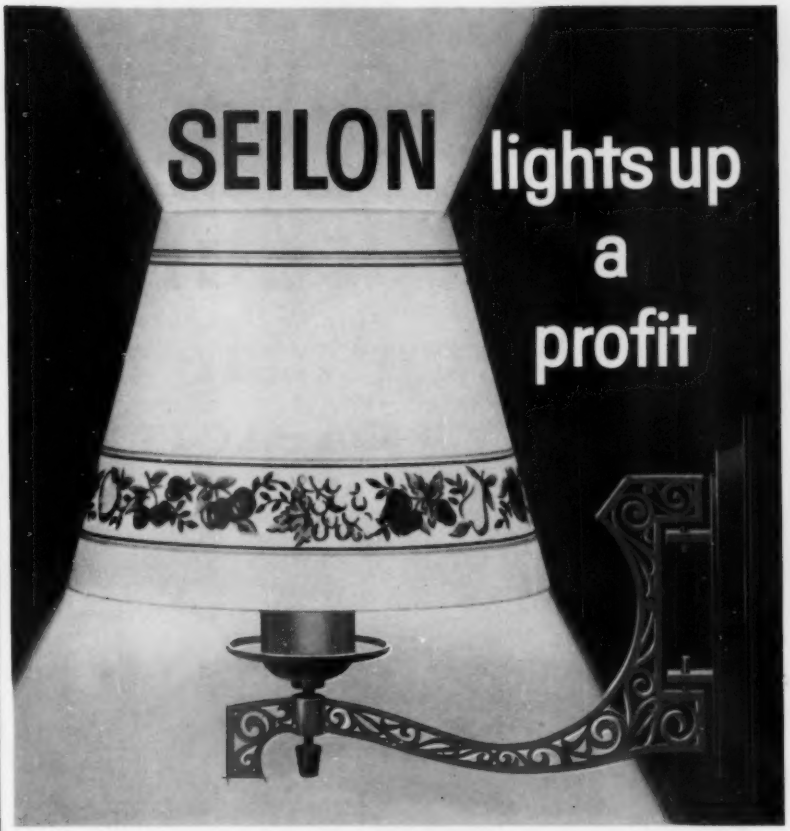
Machinery for applying decorative plastics finishes. Specifications, schematic diagrams, features, etc., for a line of hydraulic presses for various branches of the woodworking industry, including equipment for laminated panels, veneered panels, fibreboard, laminated woods, etc. 16 pages. *Becker & Van Hüllen, Krefeld, West Germany.* U. S. agent: *Karlton Machinery Corp., 210 E. Ohio St., Chicago 11, Ill.*

Plastic gate cutters. Features, prices, and other data for 13 models of gate cutters, including special concave, convex, 45-degree-angle cutters. Sample cutter kits available. 16 pages. *Injection Molders Supply Co. Inc., 17601 South Miles Rd., Cleveland 28, Ohio.*

Hydraulic presses. Specifications, models available, uses, and other data on a line of plastics laminating, compression molding, and transfer molding presses, and other hydraulic equipment. Includes charts showing hydraulic, pneumatic, and electrical symbols; superheated and saturated steam tables; etc. Catalog P-95. 36 pages. *The French Oil Mill Machinery Co., Piqua, Ohio.*

Pigments. "Perox and Hytherm Colors for Plastics" describes this line of coloring agents. Color sample kit, consisting of mounted samples of Perox and Hytherm polystyrene chips of varying thicknesses, is available upon request to the company. 4 pages. *Patent Chemicals Inc., 335 McLean Blvd., Paterson, N. J.*

Epoxy resins. "Spray On Bakelite Epoxy Resins" outlines techniques, applications, and safety precautions for these resins. 10 pages. *Union Carbide Plastics Co., 30 E. 42nd St., New York 17, N. Y.*—**End**



MAKE YOUR PRODUCT MORE APPEALING, cut your material and production costs, and you'll make a better profit—that's basic economics. It's also the profitable experience of The Verplex Company of Essex, Connecticut, the largest manufacturer of replacement lampshades. When Verplex recently decided to introduce a new line of roll-over shades, the requirements were superior quality and more economical production. They found the answer with:

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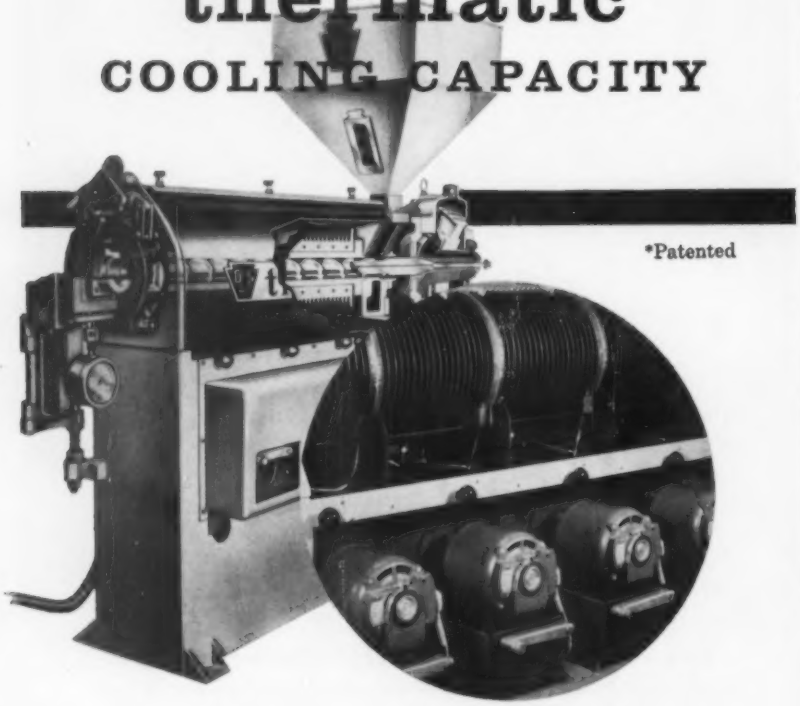

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D-S Thermatic cooling capacity permits lower stock temperature of the extruded tube for faster mold cycles.

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Reinforced molding

(From pp. 80-84)

expensive tooling; lower reject rate; and, a slash of about 50% in the cost per cover.

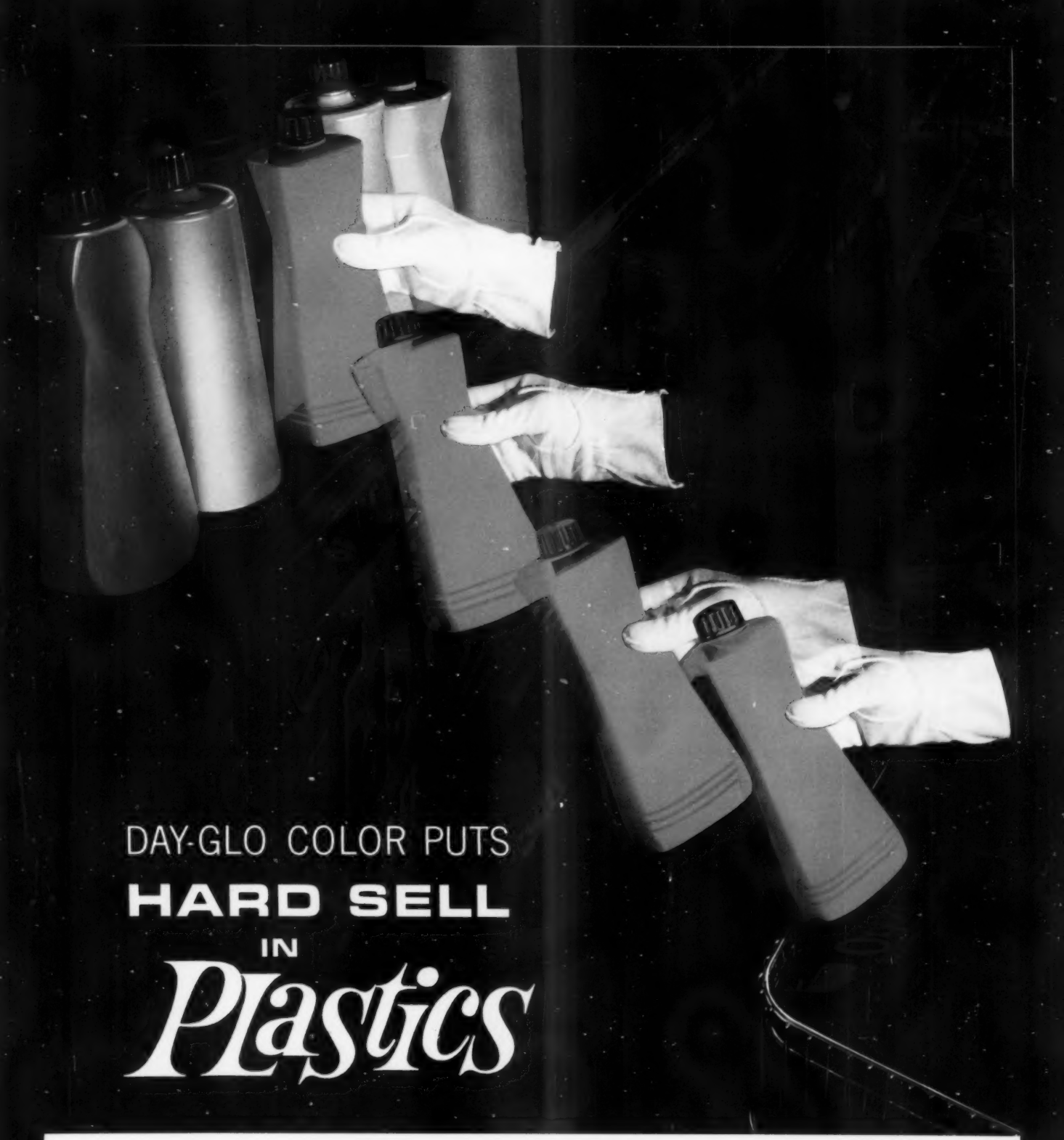
In another recent housing application, glass-polyester premix has afforded excellent surface finish and high heat resistance to the housing of a film editing-viewing unit. The compound used for molding this three-part housing was purchased in extruded form, which is said to provide the superior surface appearance. Heat resistance is vitally important in the viewer lamp housing, where temperatures often get up as high as 300° F. (See photos on p. 83).

Another housing component molded in a reinforced thermoset material is a premix receiving hopper for a milk-vending machine, which resists lactic acid, offers an attractive surface, and withstands the constant impact of the milk cartons as they drop into position.

Appliances: One of the most promising markets for the corrosion-resistant thermoset molding compounds lies in the appliance industry. The main push by suppliers of this type of compound is just now getting under way, but already there have been reports of appliance parts molded from the reinforced thermosets. Close attention will be paid to developments emanating from one major appliance manufacturer, who reportedly will soon introduce premix pump components in a new electric dishwasher line. It is presumed that the parts have been redesigned in plastic to resist attack from food acids better than do metals.

In an application closely allied to the appliance field, a molded premix laundry tub has received such an enthusiastic reception from consumers that many now talk of heavy concrete counterparts as products of the past. The big reason for the use of premix was the fact that it afforded a more attractive tub, with many molded in colors available. There were also the weight savings possible: the tub weighs only 10 pounds.

Miscellaneous applications for the reinforced thermoset molding compounds illustrate the extent to which markets are broadening for these materials. The boat industry,



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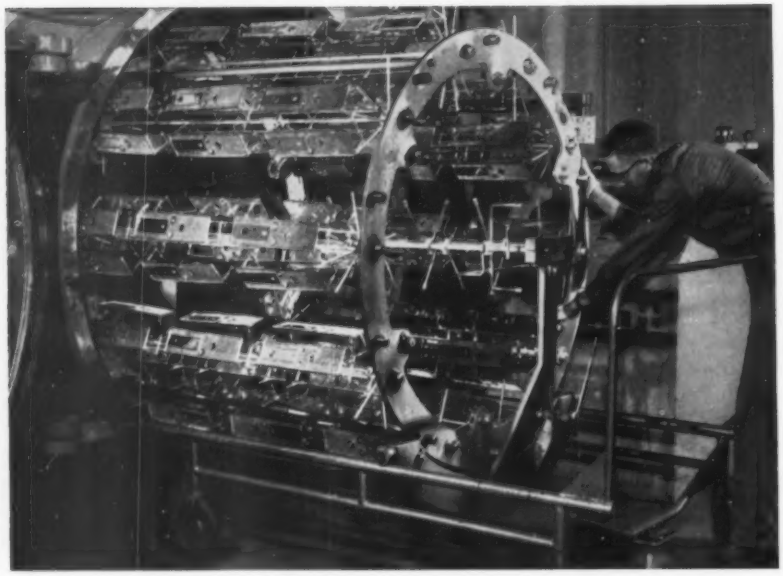
STOKES vacuum metallizer

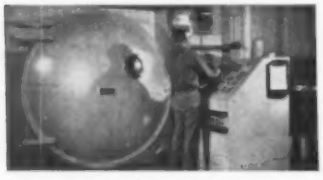
"...pays off in faster cycles, higher quality, and greater flexibility."

—Amos Molded Plastics



With this Stokes 72" Vacuum Metallizer on the production line, Amos Molded Plastics* can now handle a greater variety of metallizing jobs . . . faster and with less maintenance.

Replacing another unit, the Stokes metallizer cuts production time almost in half for a wide variety of products, including tail-light assemblies, control panels, and many others. The metallizer averages better than 25 loads in each eight-hour shift!



The selection of the Stokes metallizer was based on a first hand observation of these units in operation. Amos Molded Plastics officials visited several plants to see how Stokes machines actually performed on the production line. Their conclusion: Stokes metallizers offer speed, quality, flexibility, and low operating cost needed for continued sound growth.

Find out what a Stokes vacuum metallizer can do to increase your production . . . lower your operating costs. A Stokes representative will be glad to give you detailed information, or if you prefer, write for literature on Stokes complete line of metallizing equipment.

**Division of AMOS-THOMPSON CORP., Edinburg, Ind.*

Vacuum Metallurgical Division **STOKES**

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which already accounts for a major share of reinforced plastics parts fabricated by other methods, is now using nylon-reinforced polyester and impact phenolic control handles for outboard motors. Potentials in the laboratory equipment field, where reinforced thermosets will contribute corrosion resistance, strength, and low cost, are quite good. Such products as housings for water meters and pump bodies will undoubtedly also be prime targets for future growth of the reinforced thermosets, particularly the epoxy compounds.

The vast consumer market is being studied closely by the producers of reinforced thermoset molding compounds. The recent introduction of a molded glass-polyester sled into the toy market is but a first step in this direction. While reinforced melamine compounds have been used for serving trays, salad bowls, kitchen appliance handles, and by the military for heavy duty dinnerware, this area is not expected to be a major source of growth, since the alpha cellulose-filled melamines are still by far the most popular materials for these uses.

The list of possibilities among consumer applications is as large, or larger than the prospects for industrial uses several years ago. And it may be worthy of noting that more potential industrial customers for reinforced thermoset molding compounds have been converted within the past year than in the preceding three years!

Credits: For supplying composite property data for the chart on p. 84, the authors wish to thank Plastics Div., Allied Chemical Corp.; Fiberite Corp.; Food Machinery & Chemical Corp.; and Reinforced Plastics Div., Society of the Plastics Industry Inc.

The authors also wish to acknowledge the material assistance of: American Insulator Corp.; Atlas Powder Co.; C.T.L. Div. of Studebaker-Packard Corp.; Durez Plastics Div., Hooker Chemical Corp.; Firmaline Products of Crompton & Knowles; The Glastic Corp.; Owens-Corning Fiberglas Corp.; Plumb Chemical Corp.; Reinforced Plastics Dept., Raybestos-Manhattan Inc.; Rogers Corp.; U. S. Polymeric Chemicals Inc.; and Williamson Adhesives Inc.—**End.**

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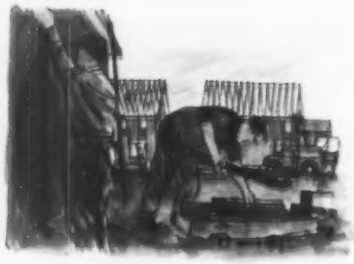
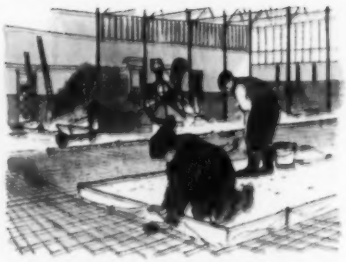
"Kodapak" is a trademark for Eastman's plastic sheet.



Stack pipes, soil pipes, rain-water goods, made from 'Corvic' vinyl polymers

'Welvic' p.v.c. covered window frames

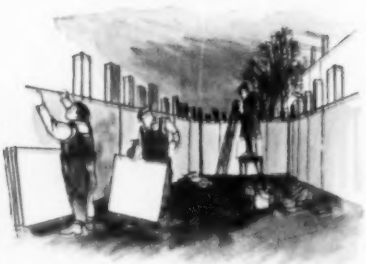


Polythene film damp and soil proof membranes under concrete

PLASTICS IN BUILDING

Lighting fittings made from 'Perspex' and 'Diakon' acrylic materials

Baths, washbasins, sinks and drainers made from 'Perspex' acrylic sheet

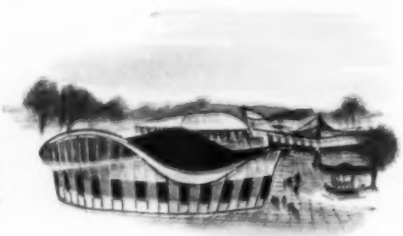


Concrete shuttering made from 'Flovic' vinyl copolymer foil

new developments–new materials

Wall panelling made from 'Darvic' p.v.c. sheet

Water cisterns, ball floats and syphons made from 'Propathene' polypropylene



Stressed skin roofs–a future development in plastics

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MEANS PROGRESS IN PLASTICS

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P136/0/A

Molded tray

(From page 85)

multi-cavity compression molds. The trays are currently being produced at the company's Taunton, Mass., plant at the rate of 25,- to 30,000 per day. At the moment, the process still involves several manual operations; however, it is expected to be fully automated within a matter of months. It is clear, when this output is compared with the anticipated market figure stated above, that this production won't begin to fill customers' needs once the market breaks open. To deal with this situation, Haveg may open several regional factories to meet local demand; and, subsequently, also license the process.

Properties, prices, prospects

The outstanding characteristic claimed for these trays is that they can withstand both the high and low temperatures encountered in the food-processing industry. The trays can be filled with food hot from the stove, hermetically sealed with high-density polyethylene film, then quick-frozen for storage. The food, still frozen in the container, can then be reheated at temperatures up to 450° F. According to Haveg, the tray can withstand this temperature for more than 45 min. without ill effect. And, as stated above, the tray is suitable for use in radio-frequency cooking devices. Aluminum trays, which reflect radio waves, can't be used; polyethylene trays placed in such a stove would soften and collapse.

The new tray does not impart any taste or give off any odor, even at high temperature.

It is possible to produce the trays in practically any color, a fact which makes it easy for the food manufacturer to color-code by package contents. It is also possible to mold in decorative designs, messages, and patterns. But no trays with this treatment have yet been produced commercially.

Current price for a standard tray is about 4 cents. As production goes up, this price will undoubtedly come down. For the time being, however, this is twice the cost of comparable aluminum containers and a little more than double the cost of competitive packages produced of high-density poly-

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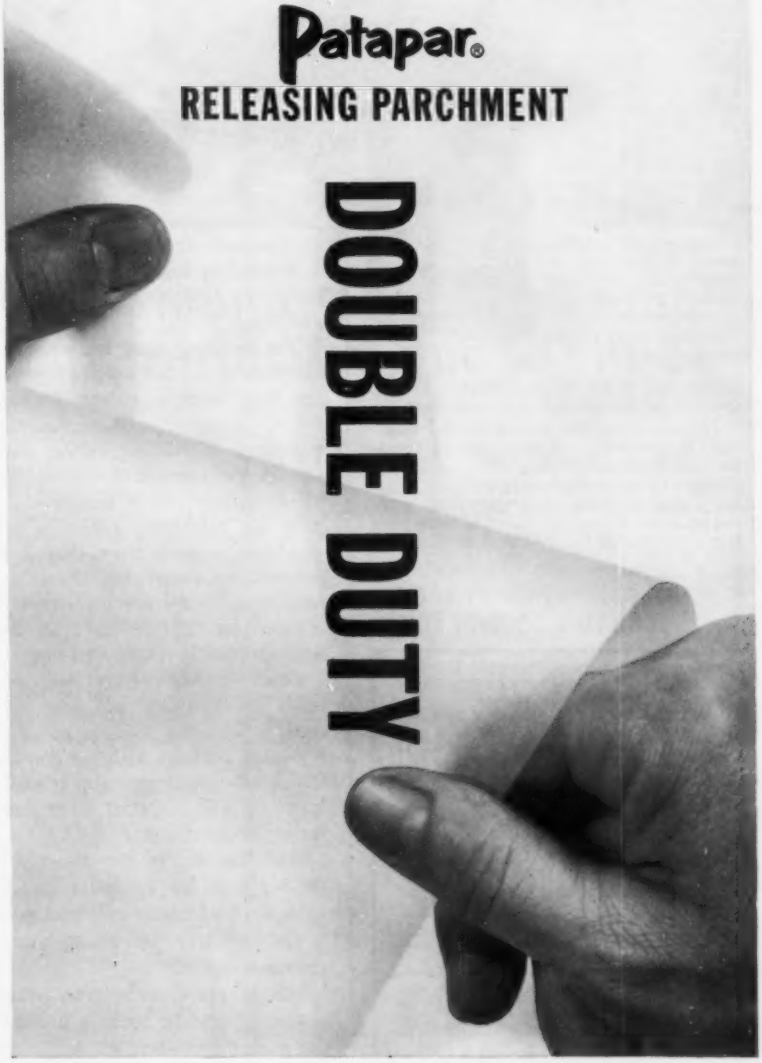

A concise, integrated guide for a tooling program—covers materials, properties, latest fabrication techniques...

PLASTICS TOOLING
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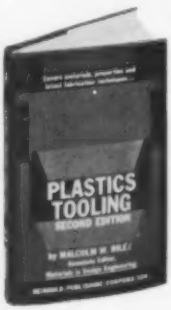
by MALCOLM W. RILEY
Associate Editor, *Materials in Design Engineering*

1961, 225 pages, $7.50

THOROUGHLY REVISED

This is a complete revision and enlargement of the author's previous guide to the properties and fabrication methods of plastics as they apply to a tooling program. Many of the materials and techniques described in this second edition are new—e.g., metal fiber-reinforced epoxies—and some are even developmental, such as gas or electroless nickel-plated surfaces for plastics tools. The author clearly states the degree of use of each technique discussed, and includes as much data as possible on those materials which have highly promising futures.



Relatively well-defined combinations of physical and mechanical properties of plastics are included, as well as the novel methods by which they can be put into a final tooling shape. There is enough resin chemistry discussed to enable the engineer to work with plastics materials and with suppliers on a sound basis.

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ethylene. Prior to the tray's introduction, high-density PE containers had made some inroads into the vending field. Claims for the PE tray include 1) low price (1½ to 2¢ per unit, including cover and printing); 2) built-in availability of tear-tape opening; and 3) non-breakability. Haveg feels, however, that the temperature resistance of its tray, its usability in radar ranges, and its other properties more than make up for the higher cost.

Among companies using the new tray is The Brass Rail, New York, N. Y. The company entered the vending field recently using a high-density PE tray. It has now started to switch over to the new container. Food dispensed in the PE tray is heated in a standard oven at a slow 2-hr. simmer, which the Brass Rail claims is necessary to bring out the best in its food. Food prepared in the new trays is currently heated in the same manner; but it's a safe guess that this cycle will shrink appreciably, and very shortly, too. In the meantime, the company has also started using the radar range in some of its cafeteria operations.

Another company in the Midwest is currently using the new tray in its vending machine systems. The machines used incorporate the radar stove.

The vending market is only the first step in the full development of this tray. It encompasses the vast factory feeding market with an estimated 18 million factory employees as potential customers. Most factories today feature company-run cafeterias, generally operated at a loss. Now that it is possible to vend hot meals at lunchtime, many a management is expected to replace its cafeterias with automatic vending set-ups.

Other vending markets, with potential consumption estimates also running into the millions of units per day, include highway service stations, travel terminals, schools, hospitals, and a host of other similar institutions.

And looming in the distance—the big goal: the American housewife, buying frozen foods packaged in the new tray for use as home-prepared meals.

Who'd have thought, even a year ago, that we'd be cooking in plastics containers!—**End**

example...

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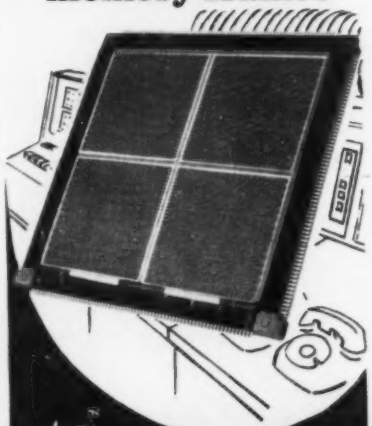

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Other helpful benefits

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Polystyrene colorants

(From pp. 88-89)

to check with the manufacturer on the colorant's heat stability, lightfastness ratings, and bleeding characteristics. This information is not conclusive, and to be sure, the compounder, molder, or extruder should evaluate these products in his own formulation, using the information from the manufacturer only as a guide.

The amount of pigment to be used also depends on the specific end-use—and can range anywhere from 0.005 to 2 percent. As a benchmark, the average is set at around 0.01 to 0.02 percent.

Dry coloring or master batch coloring are the two forms in which colorants are being used for coloring polystyrene. Flushed colors are not used for this purpose since plasticizers, which are one of the vehicles used in the flushing process, are not used in polystyrene formulations.

The amount of colorant needed to produce a given shade is an important influencing factor in the compounder's decision to use either dry colorants or master batch. If the formulation calls for a comparatively small amount of colorant compared to the total formulation, master batches are usually used, since they afford a more accurate means of weighing and blending.

Recently, the development of mechanical mixing inserts mounted in the nozzles or cylinders of injection molding machines has aided the molder who does his own dry coloring. For the large processor or basic resin manufacturer, heavy-duty dispersing equipment can produce even better dispersions.

Whatever process is used, since the cost of colorants may vary from a few cents a pound to as much as $30/lb. for the highly specialized vat pigments with outstanding heat, light, and chemical fastness, it is essential that full color development should be achieved—and this may have an important bearing on the economies involved in the choice of a processing technique.

In general, dry coloring is more economical than master batch coloring since it eliminates the middle man. The use of colored resin purchased from the supplier increases cost somewhat more. The volume and shade sought in a particular application may also influence the choice.

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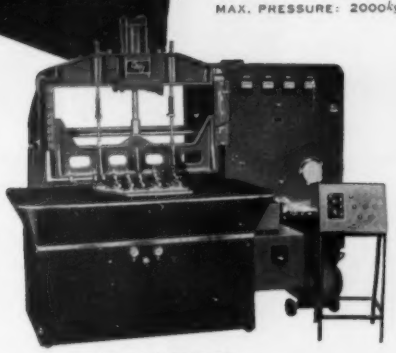

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Property	Plasticizer (60 PHR) TXP-126	Polymeric "A"
100% Modulus, psi	1600	1500
Tensile Strength, psi	3000	2750
Elongation Retention, %	90	90
Extraction, % loss		
Soapy Water	1.0	2.1
Activated Carbon	0.7	0.7

Comparison of TXP-126 and DOP in Fused Vinyl Plastisol Film

Property	Plasticizer (100 PHR) TXP-126	DOP
100% Modulus, psi	670	540
Elongation Retention, %	95	10
Low Temp. Flexibility 35,000 psi, °C.	−42	−55
Extraction, % loss		
Soapy Water	2.6	0.6
Heptane	43.0	43.0
Activated Carbon	1.3	2.8

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Monofilaments

(From pp. 92-95)

outlast natural bristles by a factor of 10 to 20, depending on what natural bristle is used for comparison. Nor is this the entire story. Down-time to refill brooms is expensive; a sweeper is out of commission and the user has to carry extra cores (at about $250 each).

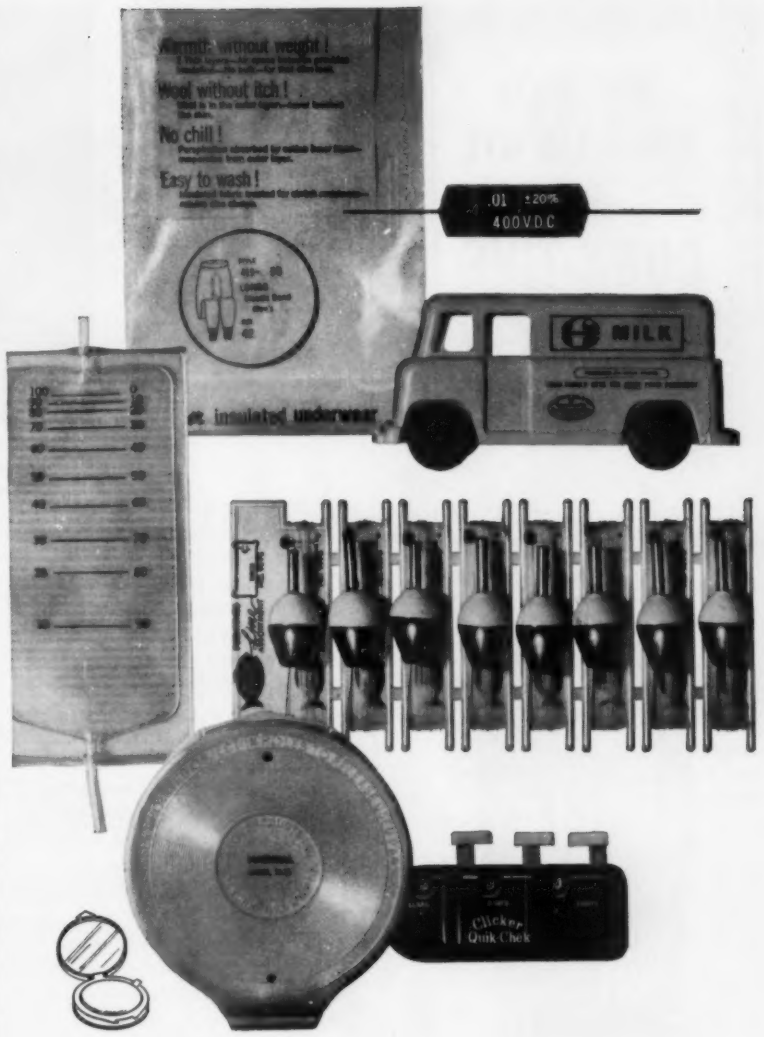
As against metal bristles, PP offers the advantages of good flex life and non-corrosion. Metal broom bristles may tend to break and shred. This is a significant factor in contract sweeping, where jobs may include airport runways and where metallic slivers may cause damage to jet planes as they are sucked into the engine.

Polypropylene bristles are about three times as costly as polystyrene bristles, but last about five times as long, according to PP producers.

Polypropylene's strongest competitor among plastic fibers is nylon. Both fibers have about the same service life, and nylon has enjoyed a high reputation as bristle material. Polypropylene bristles makers base their sales argument on low cost, low water absorption, and fine and heavy debris: polypropylene bristles sell for around $1.50/lb.; nylon bristles, until lately, ran at $2.40 to $2.90/lb.; PP fibers do not absorb water, nylon bristles do. However, recent activity by Du Pont may cast a new light on this situation. As detailed on p. 162, a new filament with a unique profile and a lower price introduced by the company may make the battle for this market less one-sided than PP people may wish it to be.

Polypropylene-bristled municipal street sweepers made their first appearance in the New England states, where they reportedly weathered the cold winter without ill effect. E. B. & A. C. Whiting Co., Burlington, Vt., reported to be the first to supply such bristles, and for distribution in the U. S., Canada, and overseas. This firm uses special, undisclosed extrusion techniques to produce a stiff fiber said to be very efficient in sweeping operations, and reportedly produces the highest degree of orientation for such bristles. This, in turn, is related to wear.

Recently, the middle Atlantic



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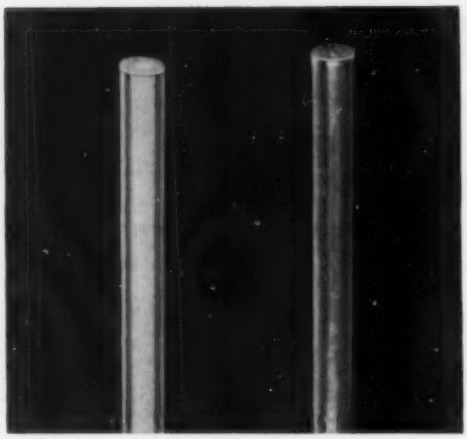

MONOFILAMENTS for mechanical street sweeper brushes. In Keystone Plastics extrusion (left), the core portion, achieved by post-extrusion chilling, looks lighter than "envelope," indicating difference in crystalline structure claimed to enhance performance. Monofilament at right is extruded by E. B. & A. C. Whiting Co. Light hue along center, produced by another technique, gives additional stiffness, resiliency, and abrasion resistance.

states have also seen the introduction of such sweepers. An extruder in that area is Keystone Plastics Inc., Newark, N. J. The monofilament produced by it consists of a core that has a different crystalline structure than the outer "shell" (see photo, p. 95). This may be the result of shock chilling or some other post extrusion technique, which the company will not reveal. In any case, the construction—which is still a single monofilament extrusion—is said by the company to provide improved bend recovery and higher tensile values, abrasion resistance and stiffness.

It is but a small step from the street sweeper to the broom market, and polypropylene has started to make inroads here, too; 1960 sales for this application were over ¼ million pounds. Milwaukee Dustless Brush Co., Milwaukee, Wis., is offering such brushes for heavy-duty sweeping of semi-rough and rough surfaces, such as coal mines, glass factories, etc.

Miscellaneous: Beyond the major market areas there are several smaller-volume applications in which polypropylene monofilaments are carving a niche for themselves. Among them are :

Grille cloth: The yearly potential for this application is about 100,000 lb., according to Dawbarn Bros. Inc., Waynesboro, Va., said to be the largest PP monofilament extruder; and the application is in radio or hi-fi speakers. At the moment, polyethylene—in raffia-type monofilaments—still dominates this market. However, polypropylene people feel that their material has

SMALL-DIAMETER ROPE and spool of monofilament used in braiding it. Spaghetti-like strands are brush bristles. Photo, AviSun Corp.

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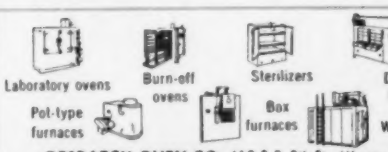

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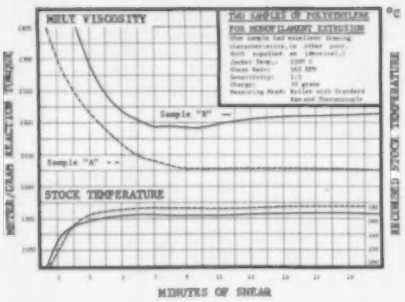

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a good chance to get into this field. They point out that raffia-type PE fibers are too shiny, and that it is very difficult to color polyethylene to match the wooden cabinets on which they will be used.

Shoe fabrics: In the developmental stage, this application involves the use of woven PP monofilaments in summer shoe uppers. The problem here is one of processing temperatures used in the shoe industry, which at this time are too high. This problem, apparently, is solvable and the application is expected to go commercial.

Luggage: Much work is being done on the use of PP monofilament for soft-sided luggage. In terms of abrasion resistance and toughness, the material seems well-suited to this application; and, as soon as the waterproofness problem is solved, success in this project is anticipated.

Scouring pads: Extruded into the proper filament shape, PP pads have good scouring action, while maintaining their pleasant feel and color; and they cannot rust.

Accessories: Belts, bags, eyeglass cases, etc., also represent an interesting potential; and several field tests are underway to determine their marketability.

There are several other applications where polypropylene monofilament might effect some penetration; however, the extent of the realistic market potential cannot be precisely determined at this moment: tentage and tarpaulins, surgical sutures, filter cloths, fish nets, and petticoats. The last application has been reported from Italy, and consists of woven PP extruded by Polymer Industri Chimiche, a subsidiary of Montecatini.

The structure of the industry

Polypropylene monofilaments comprise an industrial area made up of resin suppliers, extruders, weavers, and end-users.

Until last year, the only domestic resin supplier was Hercules Powder Co. Since then, several other companies have entered the field, all offering special filament grades (For complete list, see the *Modern Plastics Encyclopedia* issue for 1961, pp. 1177-1179). There are about 15 extruders of polypropylene monofilament, with most of the business concentrated in the hands

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of four or five. And there are many companies weaving narrow fabrics, making cordage, etc., who produce the finished product.

It is interesting to note that there is very little integration among these various segments of the industry, and for good reasons.

Extruding natural polypropylene from a single extruder represents no great problem: perhaps $35,000 for the extruder and accessory equipment. But where large volume is required and several colors are involved, considerable investment and extensive technical knowledge are needed. And besides the actual extrusion, there is the problem of packaging the monofilament. Extruders must either install special winding equipment or invest in spools. Firestone Synthetic Fibers Co., for example, has over 1.5 million spools, for which they pay $2 each. These spools have a turnover of about five times a year and have a life expectancy of two years.

There have been several attempts at integration in the past. But, with one or two notable exceptions, they have failed. However, the picture may be changing. Hercules' acquisition of Industrial Rayon's Covington, Ky. facility seems to indicate a move into the PP fiber field, although industry feels that it's a move into multifilament or staple fibers. And Firestone is bringing a polypropylene plant on stream.

Beyond the monofilaments is the prospect of staple fibers and multifilament yarns for the textile industry. In addition to Hercules, Reeves Bros. Inc. is attempting to establish a position in this field; and trade pundits are sure that much of Eastman Chemical Products' PP production will also end up in textile fiber. But while sample materials have been shown at a number of trade exhibitions, full development of this aspect is still several years away.

Acknowledgment

The cooperation of the following companies in supplying background information is gratefully acknowledged: AviSun Corp.; Eastman Chemical Products Inc.; Enjay Chemical Co.; Dow Chemical Co.; Firestone Synthetic Fibers Co.; Hercules Powder Co.; Montecatini Soc. Gen.; Spencer Chemical Co.—**End**

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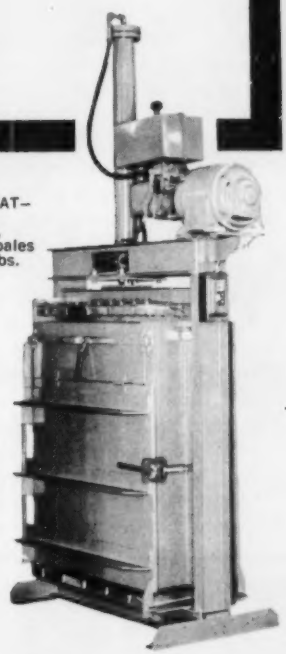

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One-piece RP hull

(From pp. 90-91)

and measure 1½ in. across the top, yet they have the same rigidity as oak frames measuring 3¼ in. by 2.78 in., which are specified by Lloyds of London for a hull of this size. And, of course, they are also much lighter.

Key to the patented method of producing the frames is a thin aluminum (or hard paper) former which is, in essence, a flat sheet notched or slit at intervals of about 1 in. on both edges along its length. The flexible former can then be folded "U"-fashion so that it conforms exactly to the contours of that part of the hull on which the frame is to be laid. Once secured to the hull, the frame former serves merely as a foundation for the first layer of mat. It has no structural value.

A layer of polyester-glass mat, still wet, is first laid over the former. After cure, a second layer of impregnated uni-directional roving is then placed lengthwise along the top of the frame to increase tensile strength. Finally, the entire frame is covered with another layer of polyester-glass mat.

Hollow ribs made in this manner can be of any size. Smaller ribs consist of two layers of resin-impregnated glass mat with one layer of roving sandwich between them along the top of the "top-hat" frames. Larger ribs generally have three or more layers of mat and two or more layers of roving.

The hull was laid up by hand in a female mold, starting with the outside skin and working inwards. A 2-oz. fibrous glass mat was used and the ratio of glass to polyester resin was 1:3. The finished hull is ½ in. thick above the water line, and ¾ to 1 in. thick below. The outer surface of the hull has one coat of gel coat, and the mold is coated with a parting agent to prevent the hull from sticking. Stiffening frames are laid upon the inside of the hull at about 15-in. intervals.

As completed, the RP hull has demonstrated outstanding physical characteristics. It already has the approval of Lloyds of London and has successfully passed tests far in excess of Lloyds and American specifications for hull timbers. U. S. standard scantlings broke at 2.7 tons load, Lloyds at 3.5 tons, and the molded RP hull at 4.5 tons. In fire tests, it stood up for 2½ min. at 1200°, approximating the peak temperature of a Bunsen burner or a gasoline fire. It charred to a depth of only 1/12 inch. Heat transfer is negligible, and there is no risk of static flash.

Is this the ultimate size for RP boats? Published figures indicate that an RP hull up to 130 ft. can be produced at the same cost of a wooden hull. And if more than one hull is to be turned out on the same mold, the economics swing strongly in favor of RP.

Credits: Ocean Commander 67 was designed by John G. Alden & Co. Inc., Boston, Mass., and built at Halmatic Ltd., Portsmouth, England, using their Deborine construction. Finishing and fitting out completed by Hodgdon Bros., E. Boothbay, Me. Crystic 189 polyester resin supplied by Scott Bader & Co. Ltd., Wellingborough, England; H.P.E. chopped fibrous glass strand mat supplied by Fibreglass Ltd., St. Helens, Eng.—**End**

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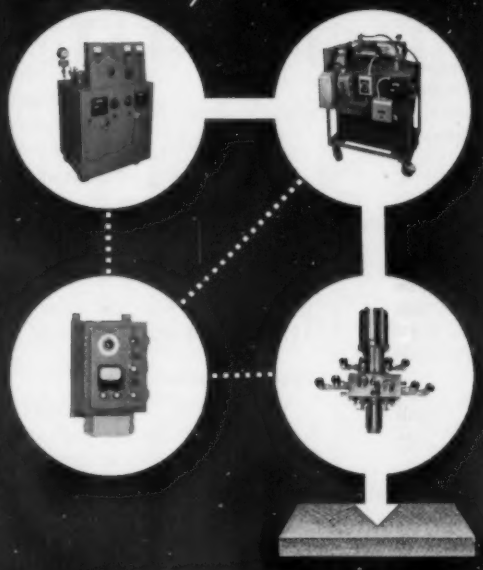

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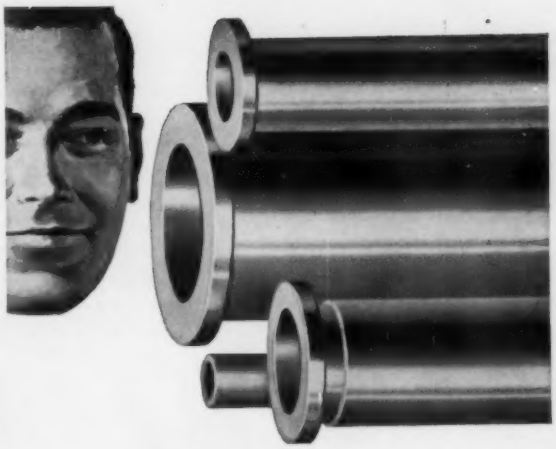

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Once upon a time . . . long ago . . . polyethylene producers had the idea that they could successfully fill all market needs with a single grade of polyethylene. A sweet dream, but fleeting. The list of formulas now offered is as long as your arm and growing every day.

Early this year when Eastman entered the polypropylene market commercially, it was with no lingering illusions of simplifying the complex needs of the plastics industry. Our first official Tenite Polypropylene price list, issued January 16, 1961, lists 15 polypropylene formulations of different flow rate and impact strength. The list includes formulations stabilized against ultraviolet radiation and formulations stabilized against heat. There are also special formulations such as those offered for food packaging use, which comply with F&DA regulations.

If you have a polypropylene application that requires a specially tailored formulation, get in touch with the Tenite representative nearest you. He can probably help.

A Fine Point

People often ask us, "If you compare polypropylene formulations having the same flow rate, how can you say that some of them have better flow characteristics or better moldability than others?"

Simple. The flow rate of polypropylene is generally measured in a 230° C. cylinder using a plunger weighing 2.16 kilograms. Here is the rub. Polypropylene formulations that flow the same under these laboratory conditions may, and often do, flow differently from one another under actual molding conditions where temperatures and pressures differ from those of the lab apparatus.

(Note that we say "flow rate." We hesitate to use the term "melt index" for polypropylene since the ASTM Standards, Section D1238, clearly define this term as a measure of flow at 190° C. under a load of 2.16 kilograms—the conditions generally reserved for measuring the flow of polyethylene.)

To really learn how a polypropylene formulation will mold or extrude, we suggest you make a trial run. We think you will be impressed by the performance of Tenite Polypropylene.

Gating for Polypropylene

Being a polyolefin, polypropylene bears a certain similarity to polyethylene. Don't let this fool you, however, when it comes to gating. Polypropylene has a sharper freezing point, a significant fact. It explains, for instance, why molders sometimes find that gates of intermediate size tend to freeze shut.

On the other hand, if you use a gate sufficiently large, it obviously won't matter if some of the melt "lines out" on the land. And small gates stay open because of the frictional heat generated as the plastic is forced through them. Small gates of 20 to 30 mils, and large gates of 90 mils and over, generally work well.

Eastman's plastics engineers can offer technical advice and assistance on processing of polyethylene, polypropylene, and cellulosics, and stand ready to help a fabricator work out knotty production problems. Feel free to write us at EASTMAN CHEMICAL PRODUCTS, INC., *Plastics Division,* KINGSPORT, TENNESSEE.

No Kernel Left Unturned

Our research laboratory finds that 15 grams of popcorn packed in a transparent plastic bag along with 1 gram of oil and ½ gram of seasoning can be popped in just 3½ minutes when subjected to the necessary heat.

Now, if you think popping corn is a bit far afield for Eastman's Plastics Division, you're right. But we thought it afforded a tasty demonstration of how packaging film extruded from Tenite Polyester can be used for quick, clean cooking. We've also baked some fairly tempting rolls in the film, not to mention boiling a toothsome vegetable or two.

The water vapor transmission rate is only 0.63 x 10^{-8} g cm/cm² hr mm Hg for this polyester film. It retains oil and grease and can be heat-sealed by means of an impulse sealer. If you're interested, the film is extruded commercially by Terafilm Corporation, Canal and Ludlow Sts., Stamford, Conn., under the trademark TERAFILM.

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Radiation

(From pp. 105-119)

beam power required for a production rate of 125 lb./hr. is

$$125/64.4 = 1.94 \text{ kw.}$$

or in round figures about 2 kw.

Including a 25% power reserve to handle temporary production surges, a 2.5-kw. output accelerator will generally be satisfactory here.

When working with plastic film, it is sometimes more convenient to have the outputs in Table III expressed in terms of linear web speeds. Table IV, p. 110, presents these data for film and sheet up to 125 mils thick and 40 in. wide.

Types of accelerators

While there is a variety of methods for producing high energy electron beams, there are fundamentally two types of accelerators, namely, direct and indirect. The direct type of accelerator—such as the Van de Graaff, the resonant transformer, and the Dynamitron—all produce a beam by continuously accelerating, in one step, a controlled discharge of electrons from a high voltage source across a potential to ground.

Indirect accelerators, such as a Linac, produce a beam which has been accelerated in increments in several stages; the electrons gain additional kinetic energy as they traverse successive steps through a beam tube. In the latter type the total kinetic energy of the electrons leaving the accelerator is greater than the energy developed by the potential across any one of the single stages in the accelerator. Schematics of the two types of accelerators are shown in Figs. 9 and 10, p. 113 and p. 119 respectively.

In general, direct accelerators are available with energy capacities up to 4 Mev; above this energy level this type of equipment becomes excessive in size because of the insulation required. For higher radiation energy requirements, indirect accelerators are preferable and are available in capacities of about 3 Mev and up.

Accelerators of commercial interest in plastics irradiation processes can be classified into three categories:

1. Low-power accelerators of modest energy capacity from 1 to 3 Mev; used where versatility and

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RECORDERS, INDICATORS. 50-page illustrated catalog describes complete line of recorders and indicators-including strip chart recorders, circular chart measuring elements. Minneapolis-Honeywell Regulator Co., Industrial Division. **(121-F)**

PLASTIC BULLETIN. Illustrated book discusses various aspects of the plastic industry. Includes information on materials for architects, information on new molding equipment, polyester/glass fibre boat hulls, etc. British Industrial Plastics, Ltd. **(126-F)**

INJECTION MOLDING. Illustrated bulletin describes injection molding specialists-molding in nylon polypropylene, Delrin, Teflon, vinyls, polystyrene, etc. Range: from fractions to 50 in. wide, 50 in. high, 25 in. draw. The Dover Molded Products Co. **(129-F)**

POLYCARBONATE RESINS. Illustrated 4-page brochure covers polycarbonate resins in standard fabricated shapes. Includes film, sheet, tubing, plate slabs, rods and discs. General information, list of properties, "where to buy" chart. General Electric, Chemical Materials Dept. **(132-F)**

PLASTICS EXTRUDERS. 8-page illustrated brochure describes 3½ in., 4½ in., 6 in. plastic extruders that offer a greater thrust and horsepower capacity, versatile modular construction, space-saving, tuck-under drive. Induction and resistance heated models, with either liquid or air cooling. National Rubber Machinery Co., Extruder Div. **(138-F)**

CENTERLESS FORM GRINDER. 4-page catalog describes features of machine designed to turn out a variety of circular formed parts at low unit cost. Specifications. Glebar Co., Inc. **(142-F)**

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precise control are required for development, or where the process requires low dose and modest throughput.

2. High-power accelerators of low- or medium-energy capacity from 0.3 to 3 Mev; for applications where versatility and very precise control are not required, and where large production rates are needed.

3. High-power, high-energy accelerators from 3 to 15 Mev; for applications where higher capital cost is justified because the thickness of the product or volume of material to be treated requires high penetration and high power.

In the first category, the Van de Graaff accelerator with its monoenergetic d.c. electron beam is most popular, especially as developmental units used in setting up full-scale production processes or for specialized applications requiring modest beam current. The 1.5-Mev, 2.5-kw. Model GS Van de Graaff is typical and costs about $55,000. (See Fig. 9.)

In the second category, several accelerators are available whose high output for a reasonable cost minimize the required outlay in terms of dollars per kw.-hour. The General Electric resonant-transformer type is an example, along with the recently developed Dynamitron offered by Radiation Dynamics Inc. While their capital cost may be somewhat higher, their high output in production overcomes the initial cost disadvantage.

Another accelerator in the second category, just being introduced, is the Type ICT made by High Voltage Engineering Corp. This d.c. accelerator has a separate power supply and accelerator. This feature, which is of particular interest for film and coating applications, allows the user an added amount of flexibility in mounting the accelerator tubes on the irradiation line, or in running several production lines from the same power source.

In the third category, where the penetration, energy, or total beam power requirements exceed the capabilities of the aforementioned accelerators, microwave linear electron accelerators, or Linacs, are available. These machines produce short intense pulses of electrons. High pulse frequencies provide high average beam power for continuous processing lines, while the ability to use single pulses of microsecond duration also makes the machine of value to a research lab in the study of molecular fragments, free radicals, and excited species of molecules which occur in the ionizing reaction in the material.

Significant advances have been made recently in the manufacture of radio-frequency power tubes which are the heart of the Linac-type system. In the near future it is expected that these advances will result in the ability to develop higher-power radiation at a lower operating cost per kw. hr. due to the longer life of the accelerator tubes, features of great interest to industrial users of radiation.

System costs

Once the proper process and equipment has been selected from a technical standpoint, the next question is that of cost. For the most part it is not possible to provide the exact cost figures for all of the ap- **(To page 197)**

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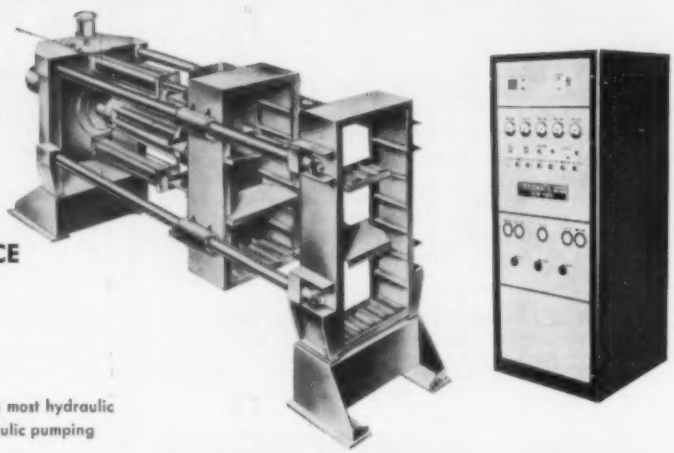

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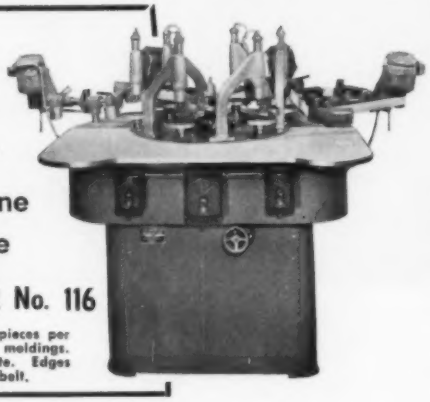

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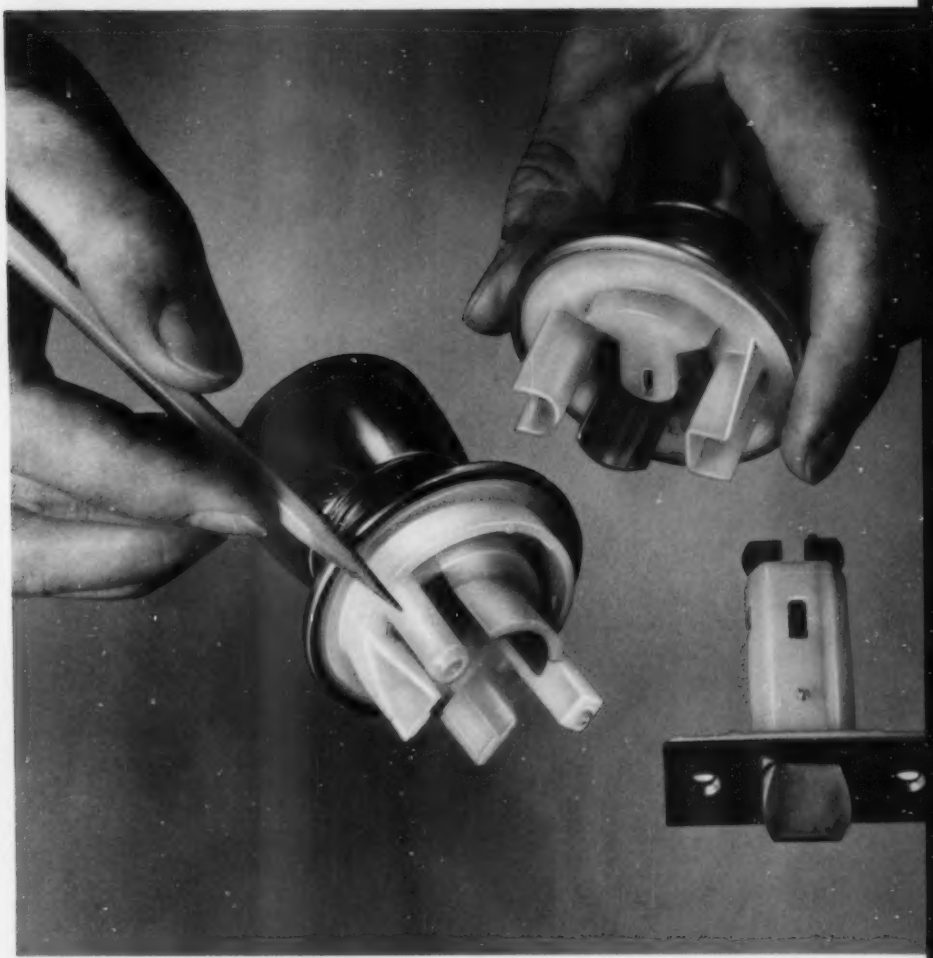

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In short, it took Du Pont ZYTEL nylon resin.

In this radical design innovation, almost all working parts except the knobs are molded of tough Du Pont ZYTEL. Installation of the lockset is made foolproof; round and square sleeves mate with round and square posts. The entire set is held by two double lead bolts that drive directly into holes in the chassis sleeves. And a self-aligning latch case lets the installer swivel the latch to the right or left of the central lock assembly for bevel-edged doors or for improper boring. In action, the bolts of ZYTEL were tested up to 1,500,000 cycles—equivalent to more than 100 years of normal household use—without perceptible wear. And the lockset functions smoothly and quietly without lubrication. Molded by Nylon Products Corp., affiliated with F. J. Kirk Molding Co., Clinton, Mass., for Lockwood Hardware Manufacturing Co., of Fitchburg, Mass., the parts are economically mass-produced, need virtually no finishing operations.

On the following page, you will find further illustrations of the design improvements and cost reductions made possible by the complete line of ZYTEL nylon resins.

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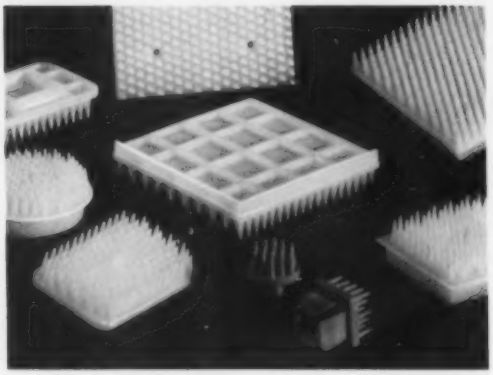
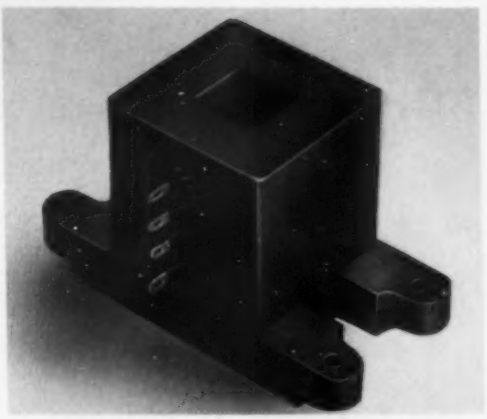


Heavy loads are supported by small carpet protectors made of ZYTEL. Support is distributed by the many tiny nylon "icicles" that reach the floor between the tufts of rug—instead of crushing the rug under the object's weight. Factors in the choice of ZYTEL were strength and resistance to creep or cold flow. (By United States Caster Cup Corporation, Kansas City, Mo.)

When installed in a teletypewriter, these wheels will be subjected to steady abrasion on the typewriter ribbon. The wheels are molded of ZYTEL, because of its impact and abrasion resistance, as well as its moldability and the exacting tolerances which can be held. (Molded by General Die Mold, Chicago, Illinois, for Kleinschmidt Division of Smith-Corona Marchant, Inc., Deerfield, Illinois.)



Coils encapsulated in ZYTEL offer high dieletric strength with relatively thin coatings. Coils are protected against humidity, acids, alkalies, and oils. The coatings can also be used as bearing surfaces, as in solenoids and contactors, thanks to the abrasion resistance and low friction of ZYTEL nylon resin. The mounting feet shown are molded as an integral part of the encapsulation. (Processed by Anderson Controls, Franklin Park, Illinois.)

Parts of ZYTEL® NYLON RESIN resist abrasion, stand up to impact, mold easily

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the applications because accounting systems and policies will vary from company to company. However, it is possible to put down a generalized cost summary for examples of each of the three categories of machines. (See Table V, p. 116.)

Capital costs and operating expenses of radiation processes have continued to drop, to the extent that a re-evaluation of many promising radiation processes which may have been shelved years ago for economic reasons is in order. Fortunately, while industry has for the most part shown a reluctance to adopt this new form of process energy, the researchers have demanded equipment characteristics in their accelerators which will also prove most useful in adapting the equipment to production processes. As a result, with the positive evidence that radiation applications are expanding their scope, the commercial processor of irradiated plastics can count on finding appropriate accelerators for his operation when he is ready with a new and different application.

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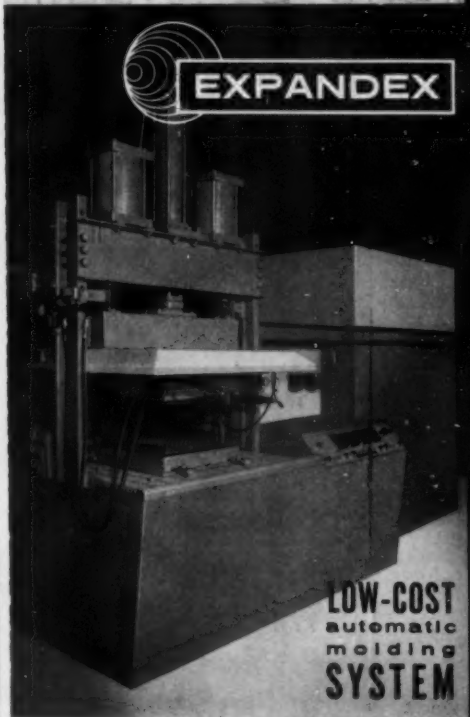

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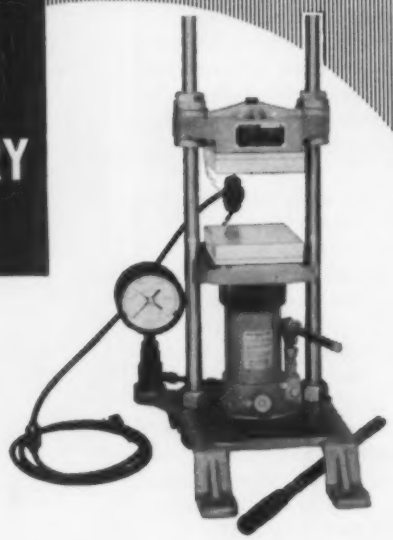

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Thermoforming

(From pp. 123-128)

vacuum box itself may not be required and we return to inverted male drape forming.

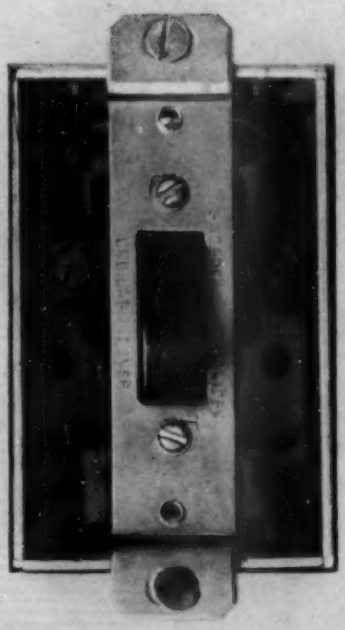
When the partial vacuum is applied in two stages, sufficient time must be allowed for controlling the second stage. Depending on the mold height, a mold speed of 8 in./sec., or less, will generally provide the needed time but the timer for the solenoid-operated vacuum valve must also be capable of controlling to $\frac{1}{60}$ sec. or less. If only one stage is necessary, faster mold speeds may be used simply to decrease the cycle time.

The vacuum box need be only a simple, four-sided plywood box—open at both ends—which will withstand the reduced pressures of this operation. The size, of course, will depend on the mold and the location of the clamps for that particular mold. For convenience, the front of the box may be a sheet of clear methacrylate so that the behavior of the sheet may be observed during the forming process.

When using a vacuum box, the bottom of the formed part can be made thicker by decreasing the depth to which the sheet is drawn into the box. Conversely, preforming to a greater depth will make the bottom thinner. At the extremes, excessive preforming will cause webbing while inadequate preforming will result in tearing of the sheet as the mold descends. Generally, the sheet should be preformed to a depth that is equal to about 50% of the mold height or slightly less.

Although, in this technique, the mold might appear to function like a plug, its temperature should be accurately controlled with circulating water at a temperature of approximately 200° F. That is to say, a vacuum snap-back mold imposes the same requirements as any other mold which is suitable for the high-density polyolefins. Plugs and molds, as discussed throughout this article, should not be confused with respect to operating temperatures.

Billow-plug forming is another technique which has been used to form parts with draw ratios of up to 1.5:1. The steps are given in Fig. 7. The two important variables are **(To page 202)**



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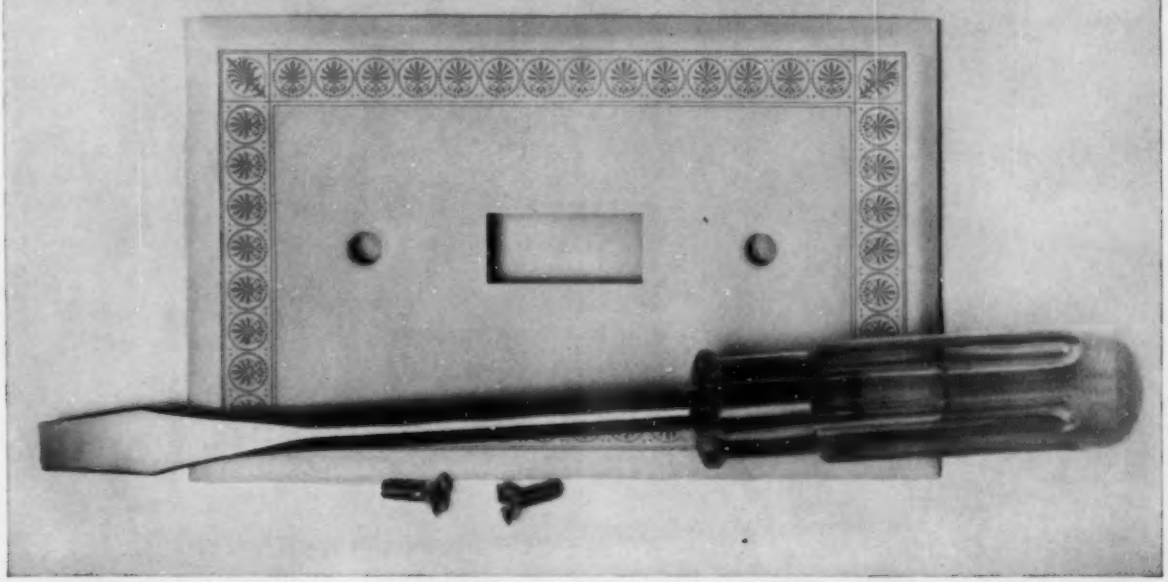

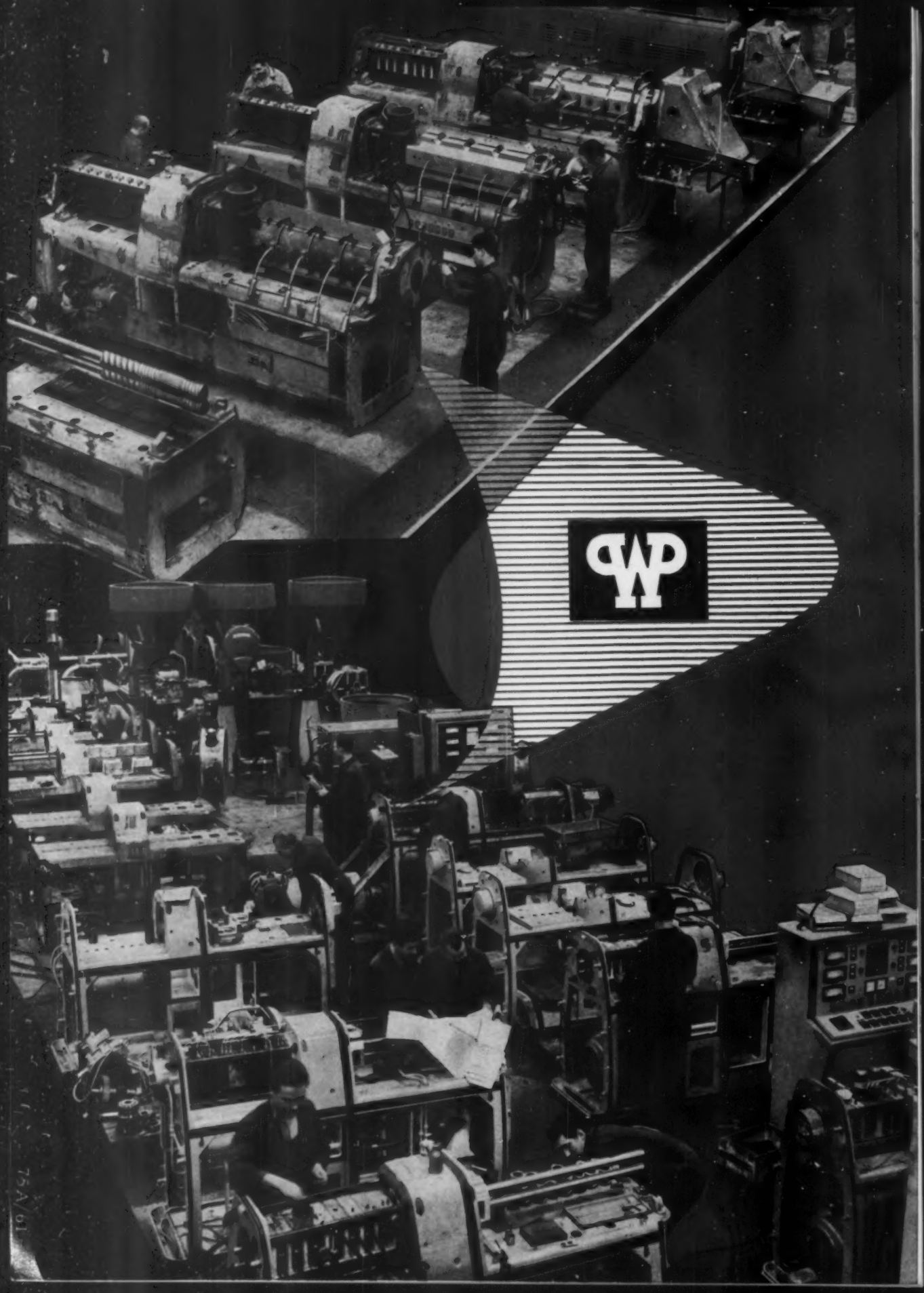

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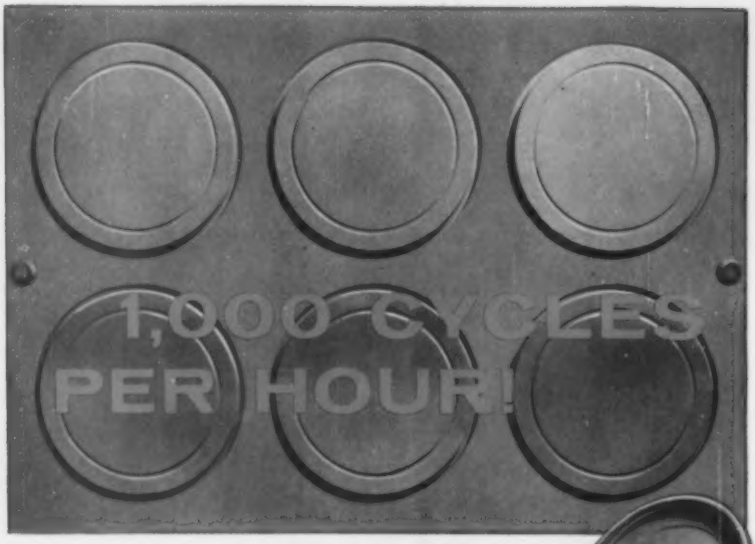

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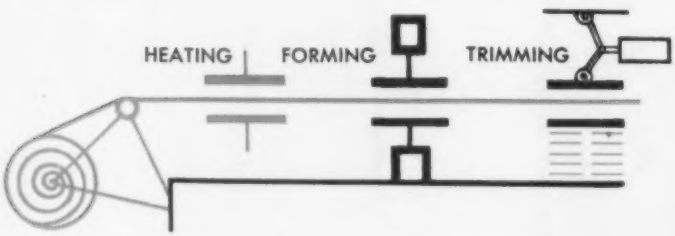

The 621 operates from roll stock and will handle any thermoplastic material sheet-thickness which can be supplied in roll form. The trim press can be installed in the machine so parts can be trimmed either up or down, through the open platen. Rule type dies may also be used.

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billow height, the height to which the sheet is blown in Step **A**, and plug penetration, the maximum distance the plug travels into the cavity in Step B. The wall distribution is largely controlled by these two factors. The bottom of the part can be made thicker, or the sidewalls thinner, by increasing the penetration of the plug or by decreasing the height of the billow. Optimum results have been obtained by billowing to a height equal to 50 to 75% of the mold depth. Billowing too high will produce an excess of material and cause webbing. On the other hand, the plug may tear the sheet if it has not been billowed sufficiently.

A pressure of about 2 to 4 p.s.i.g. under the mold has proved to be adequate for a good billow. These relatively low pressures allow more time to complete the billowing action and, hence, permit better control over the billow height.

In many cases, it is essential to provide some means for controlling the pressure under the sheet as the plug descends. The air between the sheet and the mold should be evacuated at a rate less than the rate of displacement of air by the plug. Only enough pressure should be maintained to keep the sheet off the sides and edges of the mold, thus allowing more material to be drawn into the cavity to contribute to the final thickness of the part. Excessive pressures may blow a hole in the sheet. Therefore, since very small vacuum holes are required with high-density polyolefins, it is generally not enough simply to vent back through these holes to the atmosphere, using a relief valve. We have found it best to evacuate the mold directly into the vacuum tank. To permit proper control of the air flow (pressure) during this critical phase of the operation, plug speeds should not exceed 8 in. per second. In addition, as discussed under "Vacuum snap-back forming," the timer controlling the solenoid-operated vacuum valve should be adjustable to $\frac{1}{60}$ sec. or less.

The products which can be successfully formed by this technique are essentially the same as those which can be formed by the vacuum snap-back process described in the preceding section. However, since this technique does in-

volve a female mold, it may be easier to form certain top lip or edge configurations. On the other hand, billow techniques can become "tricky" unless the sheet has been held to close thickness tolerances and otherwise exhibits an excellent degree of uniformity.

Billow snap-back forming, also known as reverse-draw forming, is almost identical to vacuum snap-back forming. The only difference is that the hot sheet is preformed by billowing, as shown in Fig. 8, Step A, rather than by drawing it into a vacuum box. Therefore, the wall uniformity of the finished part is governed largely by the billow height, *i.e.*, the height to which the sheet is blown upward. The bottom of the part becomes thinner as the billow height is increased. Billowing too high will give an excess of material which will naturally cause webbing. With not enough billow, the mold may tear the sheet as it travels into the vacuum box. For most purposes, the optimum billow height is between 50 and 75% of the mold height.

The application and control of the partial vacuum used to evacuate some of the air under sheet during the movement of the mold is again critical. Therefore, it has been found best to use slower mold speeds in this particular technique so that proper regulation can be provided.

Cooling stage

Common to all of the preceding seven forming techniques is the final cooling step. In many cases, the cooling time on the mold will constitute a major portion of the overall cycle. Obviously, this stage of the forming operation deserves careful consideration.

The effectiveness of ambient air, forced air, and a water spray are compared graphically in Fig. 9, p. 128, for a range of thicknesses. To provide a constant and well-defined reference point, these data are plotted against the time required to reach the crystallizing (freezing) point of the polymer, *i.e.*, when natural (unpigmented) sheet goes from "clear" to a semi-translucent white. "Ambient air" represented on the graph represents an environment of about 68° F. without drafts or other accelerated cooling conditions. By **(To page 208)**

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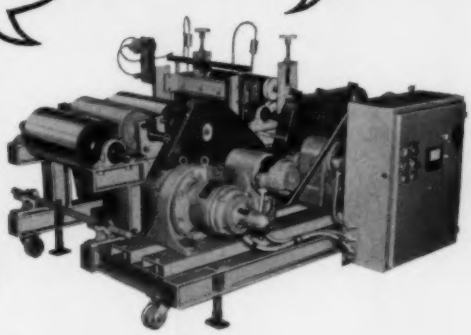

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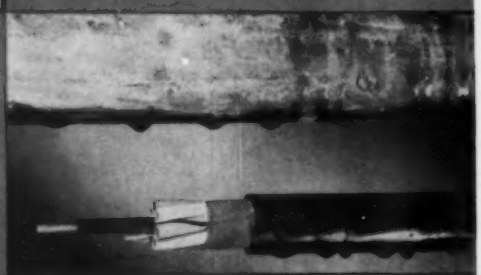

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PLASTICS EXTRUDERS. 8-page illustrated brochure describes 3½ in., 4½ in., 6 in. plastic extruders that offer a greater thrust and horsepower capacity, versatile modular construction, space-saving, tuck-under drive. Induction and resistance heated models, with either liquid or air cooling. National Rubber Machinery Co., Extruder Div. (138-F)

VINYL PLASTICS. 16-page illustrated book describes polyvinyl chloride resins. Includes information on plastics for wire and cable, rigid extrusions, flexible extrusions, molding, foam and sponge, plastisol molding, etc. B. F. Goodrich Chemical Co. (139-F)

ELECTRONIC SEALING MACHINES. Illustrated literature describes line of electronic heat sealers and generators. Includes 2-post, 4-post and guillotine presses, a 250 watt rotary sealer, and generators with from 1 to 50 KW. output. Mayflower Electronic Devices, Inc. (140-F)

FOAMING CONVEYOR. 4-page illustrated brochure describes features and applications of a conveyor for continuous plastic foaming. M-H Standard Corp. (141-F)

CENTERLESS FORM GRINDER. 4-page catalog describes features of machine designed to turn out a variety of circular formed parts at low unit cost. Specifications. Glebar Co., Inc. (142-F)

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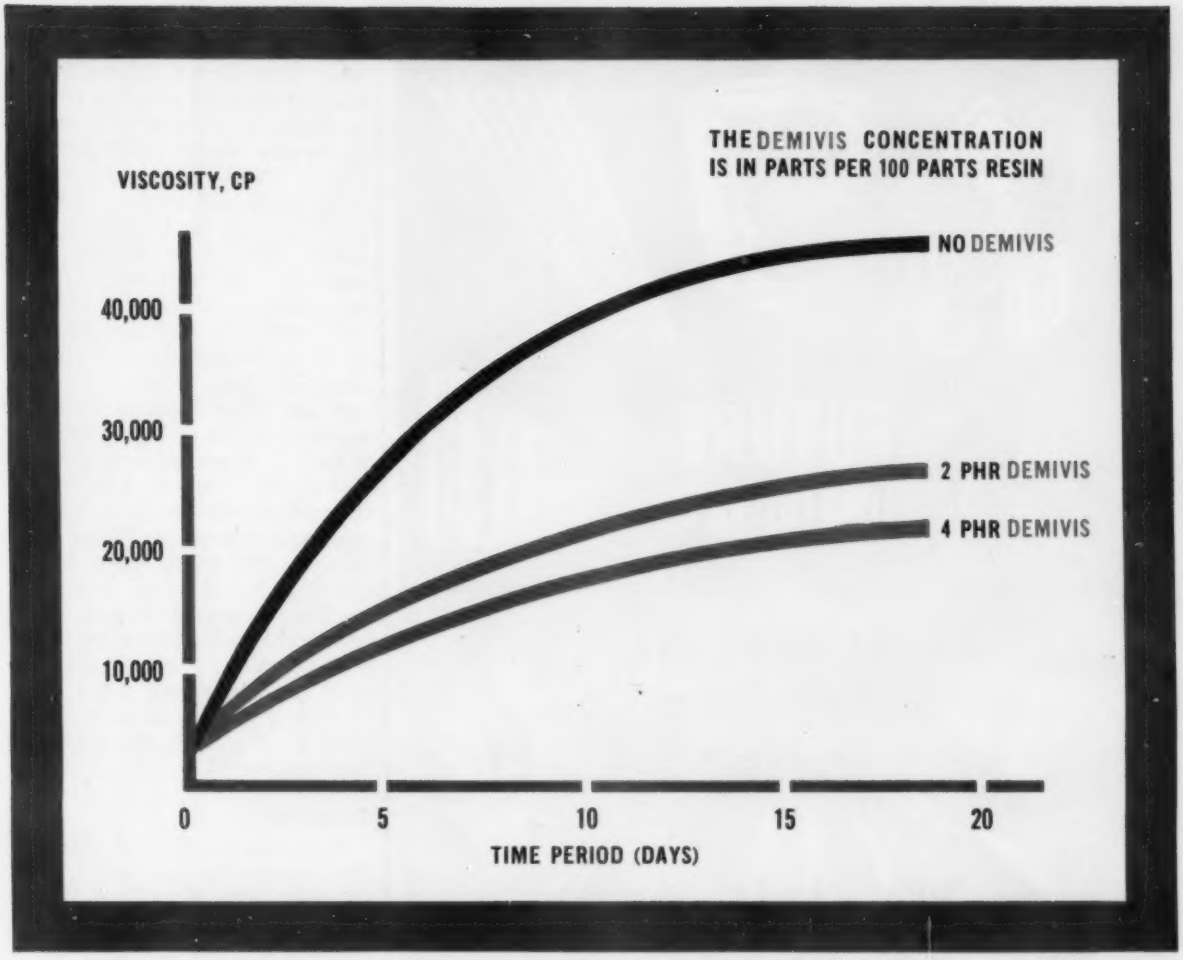

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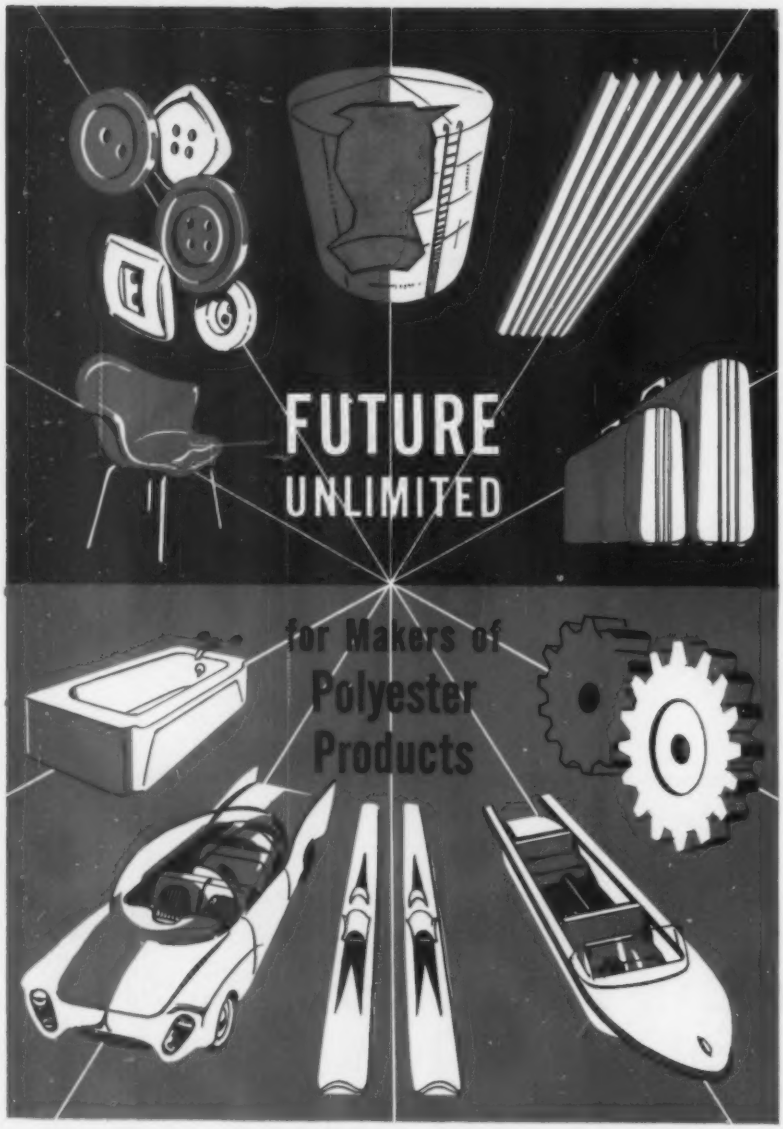

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directing "forced (room temperature) air" on the parts immediately after forming, the cooling time may be reduced by more than 20%, as shown. By spraying a fine mist on the parts instead, a 70% reduction is demonstrated. However, a water spray will produce "water marks" or "pock marks" on a molten polyethylene surface. In some cases, this effect can actually be employed to advantage as a low-cost method of producing attractively textured parts on a male mold from plain sheet. In the more general case, either a smooth surface or some specific embossed design is desired. Hence, we have evaluated the use of forced air to "set" the surface, followed by a water spray to accelerate the balance of the cycle. The results appear very promising and this work is being continued. Meanwhile, we note that commercial equipment has become available for a "water coolant spray" so it is apparent that a lot of thought is being given to this problem of reducing the cooling time on the mold.

Summary

Each different type of plastic sheet imposes its own special requirements. The natural sag and non-slip properties of high-density polyolefin sheet during the forming operation limit this material to basic draping procedures with single, fixed platen machines.

With more recent and versatile equipment available, it becomes practical to improve the wall uniformity and to greatly increase the draw ratios by going to various preforming techniques. The relative merits of the five preforming techniques and the two basic procedures for drape forming are outlined in the Selection Chart.

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1. Robert Doyle and D. E. Allison, "Designing thermoforming molds for linear polyethylene," SPE Journal *16*, No. 3, pp. 263-265 (March, 1960).

2. Robert Doyle, "Extrusion of sheet from high-density polyolefins," SPE Journal *17*, No. 2, pp. 165-169 (Feb., 1961).

3. "Giant thermoformed parts," Modern Plastics *38*, No. 1, pp. 91-96, 180, 182, 185, 188 (Sept. 1960).—End

Acrylic polymers

(From pp. 133-139)

found. Uniaxially stretching Composition I resulted in tearing of the specimen around the grips unless the ends of the specimen were post-cured. In order to accomplish this for biaxial stretching, it would be necessary to cure the rim of a square specimen, making it then impossible to stretch in both directions at the same time.

However, domes can be blown quite readily and the so-called "top hat" procedure was used for the preparation of specimens for use in the determination of the K-toughness factor.

Figure 4A, p. 136, shows the apparatus that was used, with a dome in position. The assembly for shrinking the dome to obtain a flat specimen for test purposes is shown in Fig. 4B after shrinkage. Fig. 4C shows the so-called top hat removed from the apparatus. Again it was found that a multiaxial stretch of over 35% led to stress crazing unless the test specimens were protected from oxygen during the irradiation step. In the case of multiaxial stretching, the stress cracking took the form of a random curved pattern as demonstrated in Fig. 5, p. 138.

Multiaxial stretches of about 55% were obtained. This corresponds to the blowing of an approximately perfect hemisphere. Table III shows the K-toughness factor values that were obtained on Composition I. Although a large increase in K-toughness factor was obtained in these tests, the values fell short of the goal of 2300. The increase in K-toughness factor was less with most of the experimental compositions.

Materials containing styrene proved to be quite resistant to the irradiation step. Fig. 6, p. 138, shows that even a dose of 14 megarads did not produce reasonable dimensional stability on stretched Composition II. The units for the ordinate on this graph were selected so that a value of 1.0 would represent complete relaxation of the stretched specimen and zero would represent no relaxation of the stretched specimen. Figure 7, p. 139, shows the relationship between irradiation dose and heat distortion temperature. Experimental composition 796-92-1 consisted of 20 parts triallyl cyanurate, 15 parts allyl acrylate, and 65 parts methyl acrylate. Note that the bottom two lines on the graph represent materials containing styrene, and the top two lines represent materials that are free of styrene. The styrene-containing materials are much more resistant to cure by irradiation than the others. Figures 8 and 9, p. 139, show the relationships of flexural strength and tensile strength, respectively, to the irradiation dose.

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1. J. Johnson and P. M. J. K. de Gooreynd, U. S. 912,418.

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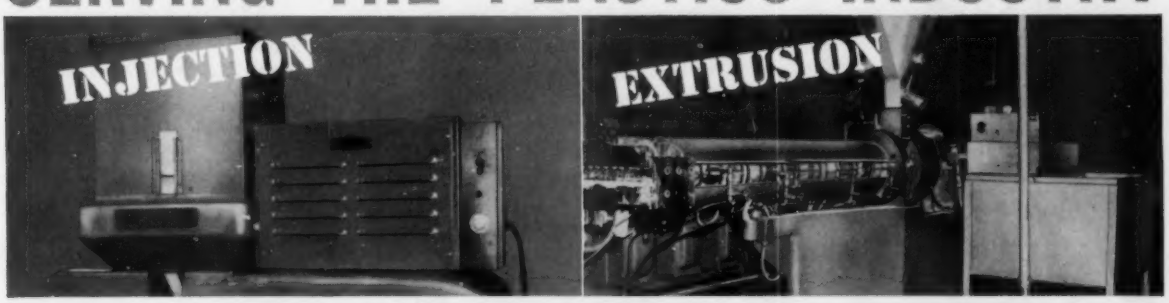

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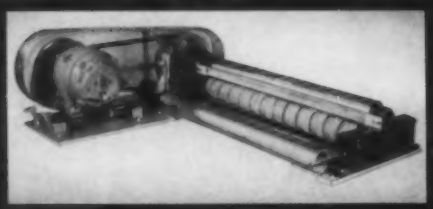

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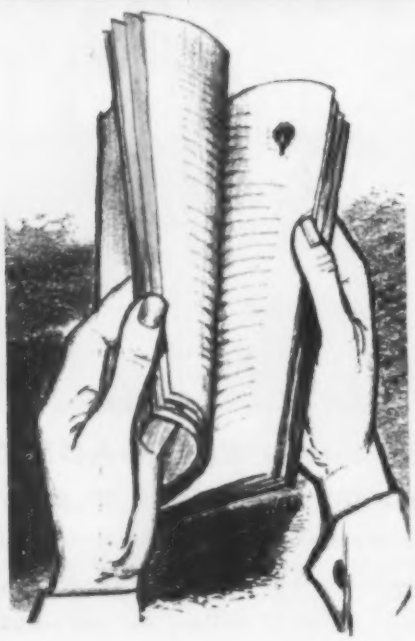

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Rheology of coatings

(From pp. 150-152)

radii. These intersections define measurable *apparent* viscosity at a given instrument rate of shear.

Procedure

To obtain reproducible rheological data, definite procedures of measurement should be set up and rigorously followed. The following is a typical procedure used for determining the flow properties of coating materials.

1. Place the test fluid in a 600 ml. Griffin (low form) beaker.
2. Allow the material to stabilize at the test temperature.
3. Insert the viscometer into the test fluid using a spindle of the appropriate range.
4. Start rotation at the highest speed. Continue rotation until the reading on three consecutive rotations is identical. Record this constant value.
5. Lower the speed stepwise and record constant values for each speed after having obtained three consecutive identical readings.
6. Plot the resulting data on the appropriate rheogram chart.
7. Draw the flow curve and extrapolate to the y-axis. The y-intercept may then be reported as the yield value.

It has been observed that making the initial reading at highest

Table II: k values for Brookfield spindles

4-spindle series

Spindle no.	*k*
	cm.^{3}
1	44.9
2	8.98
3	2.245
4	0.449

7-spindle series

Spindle no.	*k*
	cm.^{3}
1	287.6
2	71.9
3	28.76
4	14.38
5	7.19
6	2.876
7	0.719

speed, and subsequent readings in descending speed order, generally results in the shortest time necessary to reach constant values. This is undoubtedly due to the somewhat thixotropic nature of the coating materials investigated. An indication of the thixotropic nature of the fluid may be obtained by comparing the reading on the first instrument rotation with the constant or equilibrium value finally obtained; the time necessary to obtain equilibrium is also important in this respect. If a considerable degree of thixotropy is indicated, the methods described here may not be applicable, or imposition of special restrictions as to measurement under constant conditions of previous shearing may be necessary.

Illustrative data

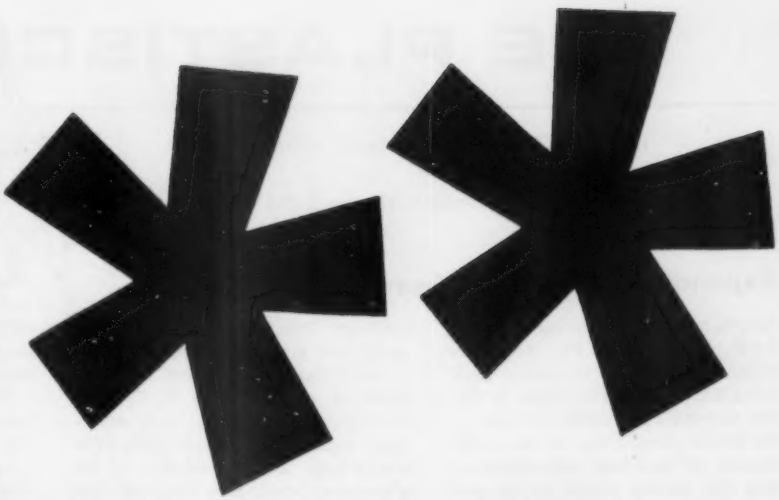
Figure 3 is a rheogram showing the flow properties of a number of coating materials encountered in the manufacture of transformers. These materials are formulated from epoxy, polyester, and silicone resins and appropriate fillers to impart reinforcement and the requisite flow properties.

Material A, which is based on a polyester resin, is used for impregnating transformers and results in an exterior coating of the order of 5 mils thick.

Materials B (epoxy-polyester) and C (silicone elastomers) are used to encapsulate transformers in a dip-coating process. The coating is applied in two dips to a final thickness of 1/16 to 3/32 inch. Although final thickness with these materials is similar, drainage time with the C material is much longer. Reasons for this may be deduced from the yield stress and slope of the curves.

Material D is an epoxy encapsulating material that results in a fairly heavy coat when applied by means of a single dip.

Material E is an epoxy encapsulating material of such high apparent viscosity that external shearing forces must be applied to complete drainage in a reasonable length of time. This is usually done by vibrating the transformer during drainage. When vibration is stopped, apparent viscosity increases to the point where, for practical purposes, further drainage may be considered to be arrested.—**End**



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THE PLASTISCOPE*

Important news . . . and what it means

By R. L. Van Boskirk

Section 2 (*Section 1 starts on p. 37*)

June 1961

Expanding markets for heavy-duty PE bags

Special emphasis on the use of 3- and 4-mil high-density PE bags for shipping produce, at the recent Packaging Show by W. R. Grace & Co., has aroused considerable interest on the future possibilities of this development. If these bags come anywhere near the volume hoped for by producers, they could become one of the finest markets available to the polyethylene industry.

Heavy-duty bags designed to hold as much as 50 lb. of material were introduced at the New York Plastics exhibition in 1956, and were then made of 10-mil conventional PE film. But there were two immediate problems: sealing such a thick layer, and cost. The chief competition, multiwall bags, was less costly and gave fairly satisfactory performance. The thick PE bags were used for some time for shipping resins and fertilizer, but with indifferent success.

The second step was development of a modified high-density (0.950) resin in which the modifying agent was supposedly polyisobutylene. It was claimed that a 6- or 7-mil film in this material would have superior properties at a cost about equivalent to heavier conventional polyethylene bags. A considerable number of these bags is being used today, although not enough to consume large amounts of resin compared with other PE outlets. A guess for 1960 would be something over 5 million lb., with producers probably using most of it for resin and fertilizer shipments.

The Grace exhibit mentioned above centered around Strong-Tex bags made by Texas Plastics Inc., Elsa, Texas. These blown film bags, made from Grace's Grex modified 0.950-density resin, are only 3 to 4 mils thick. The first big use has been for shipping 48 one-lb. bags of carrots that were packaged in conventional PE. The 1-lb. packages are moved on a conveyor belt to the master bag and automatically packed therein. The bags are sealed with a wire loop. The new bags allow the use of "top icing" for refrigerated cars, said to be impossible with multi-wall paper bags. These bags have also been used for cabbage, lettuce, grass seed, peat moss, and processed manure.

Advantages of the new bags are listed as savings of up to 70% in weight and freight costs over multiwall bags, less storage space for empty bags, and reduced costs of replacement (breakage is less than with paper bags). The package is much less expensive than commonly used wire-bound wooden crates for top iced shipments. The bag maintains a desirable high humidity for certain vegetables permitting them to arrive in excellent condition. Furthermore, if a black film is used, the bags may be used outdoors and covered with a tarpaulin.

There seems to be some difference of opinion in the trade concerning the use of 3-mil vs. 5- or 7-mil high-density resin bags for hygroscopic products such as chemicals, caustic and salt products, fertilizers, seeds, cement, and lime. Opponents say barrier properties in the thinner film are not good enough in some applications but defenders of the thin film say it is adequate for most products and that trial and error will soon determine which products can be safely packed in the new bag. However, the high-density producers staunchly assert that a 4-mil linear PE film will have just as good a water vapor transmission barrier as an 8-mil conventional PE film.

The heat sealing situation for heavy-duty PE bags is generally recognized as a technical problem that is steadily becoming less troublesome and will soon be completely overcome. All concerned are frank to admit that some sealing jobs are much better than others. The bottom seal can be satisfactorily done on a bar-type, automatic sealer if the operator knows his business. A successful top sealer is said to be a Doughboy band sealer used on a conveyor line in which the tops are flattened out by an attendant just before sealing between the two heated, moving metal bands under control pressure.

High flow polypropylene

Commercial availability of two new Escon polypropylene grades has been announced by Enjay Chemical Co. Designated 107 and 117, they are designed to give extra high flow, permitting maximum cycle retention by the faster filling of even the most complex molds.

Flow characteristics of the new grades also allow easier molding of thin-wall sections and encourage the reduction of molded-in stresses, according to Enjay. Escon 107 and 117, which possess an identical melt index (12 at 230° C.) differ in that 117 contains only additives approved by the FDA.

Price of the new grades is 42¢/lb. in 20,000 lb. lots and in natural color.

Aromatic secondary plasticizer introduced

Secondary plasticizers are generally used as comparatively small percentages of vinyl chloride formulation. However, Kendall Refining Co., Bradford, Pa., has now introduced a 99% plus aromatic secondary, Kensol PL-1, claimed to have exceptional compatibility with vinyl at up to 80% of the plasticizer content, in some vinyl copolymer systems it can even be used alone as the primary plasticizer. Other secondaries are mostly naphthenic, although one other is 75% aromatic. Since this plasticizer is only 19¢/lb., compared with the 26¢ list price for DOP, it could help provide a plasticizer system for 20.3¢/lb. if used at 80% of the plasticizer content. Other secondaries are somewhat lower cost per lb., but can't usually be used in such high concentration.

Kensol PL-1 can be used for almost any vinyl formulation or end use. However, it gives a light tan color in clear film, and is not satisfactory where a white pigmentation is used. Neither is it suggested where undue exposure to ultraviolet light is likely to be encountered. It is also somewhat more volatile than DOP, and is, therefore, not suggested for finished items that are to be used at high temperatures. But volatility is no problem during fusing if the right proportion is used. It confers excellent electrical properties on formulations where good resistivity values are required.

It is highly resistant to soap and oil extraction. An 80% Kensol-20% DOP mixture is considerably more resistant than a straight DOP formu-

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THE PLASTISCOPE

(From page 212)

lation, according to the manufacturer. The 80-20 formulation also increases tensile strength but elongation or stretch drops off, which is often a desirable property.

Since plastisol formulations generally require large quantities of plasticizers, this same Kensol PL-1 is said to be particularly economical. The plastisol's viscosity stability during storage is said to be enhanced when this plasticizer is used and the initial viscosity is also lowered, thus facilitating handling.

Density of PL-1 is 1.021; there are 8.59 lb. per gallon; and boiling range is 305 to 370° C. As to toxicity and handling, Kensol PL-1 is similar to many other compositions that have been handled in the industry without adverse effects.

This same product will be offered by Wyrough & Loser, of Trenton, N. J., under their designation Plasticizer 222, to the insulated wire and cable industry in particular.

New coating for paper

The marriage of plastics to other materials has nearly always been counted upon to furnish additional big volume use for the plastics industry. A newly announced development in a coating resin for paper could reverse this trend. This resin-paper marriage has been developed to upgrade paper so that it will be more competitive with plastics.

The producer of this upgraded paper product is Potlatch Forests Inc., Lewiston, Idaho. It is described as a new type high-barrier designed to compete with plastics, metals, and glass. Early applications are expected in bakery boxes, meat trays, picnic plates, and cups. The possibilities run from cookies, cereals, dehydrated soups to fresh and frozen foods and mustard, sauces, sirups, milk, cosmetics, shampoo, soap, and tobacco products. Industrial uses range from packages for motor oils to cement, fertilizers, seed, chemicals, photographic film, and pharmaceuticals.

The resin used is Daran, a comparatively new material by Grace's Dewey & Almy Chemical Division. It is polyvinylidene chloride in a water base emulsion with what is claimed to be a higher solids content than its competition (it would thus dry faster). Until recently polyvinylidene chloride for coating was generally used in a solvent solution, as it is for coating cellophane. But paper mills apparently don't care for solvent coatings. The water base emulsion may be applied by standard coating methods such as air knife, roller, or doctor blade in conventional curtain wall coating. It requires only 7 lb. per 3000 sq. ft. ream of paper, compared with 10 lb. of extruded polyethylene film, to give the same barrier against moisture vapor transmission, according to company reports. Price of Daran is 45¢/lb. solids. It is supplied at 60% solids.

Potlatch says its product holds promise of being the most significant advance in the art of imparting characteristics of plastics to paper since the introduction of extrusion-coated polyethylene. It could act to accelerate the development of a single-wall construction carton, which would eliminate the need for expensive overwraps or liners as moisture, grease, and gas barriers. It is also said to provide superior protection for freshness, flavor, aroma, and crispness. In many applications, it is less expensive than glassine. Being flexible, it can be scored and folded, as wax cannot. It is also often less expensive than polyethylene because it is laid down in a thinner film as noted above and reportedly has better grease and gas-resistant qualities, as well as more abrasion resistance. In some cases it might even be acceptable as a replacement for foil.

More nylon formulations

Three new nylon formulations are described in Spencer Chemical Co.'s recently published brochure, which gives details on the company's complete nylon line.

The new formulations are:

Nylon 401A, a general-purpose molding material with high-flow characteristics at lower processing temperatures. It has low shrinkage and clarity in thin sections. Suggested for precision molding.

Nylon 605A, for rapid molding of high-strength products. Suggested for rapid molding of products requiring maximum durability.

Nylon 613, for extrusion and injection molding. Medium viscosity. Suggested for clear monofilament extrusion because of flexibility, good draw, strength, and resistance to abrasion.

Liquid Novalac resin

A new low-viscosity epoxy Novalac, claimed to be suitable for ultra-high-temperature potting, casting, dipping and coating compounds, has been announced by Isochem Resins Co., Providence, R. I. Designated Isochemrez 460 series, the resin is reportedly stable from −60 through 280° C., and when used with Hardener #63, will not degrade under long high-temperature operation, the company states. Isochemrez 460 is available in various colors, filled and unfilled, and can be modified to meet each customer's specifications.

Silk screen ink for cellulose acetate

A new paste-type ink, formulated especially for use on cellulose acetate surfaces, has been announced by Schwartz Chemical Co. Inc., Long Island City, N. Y.

The new ink, which has the viscosity of heavy molasses, dries fast on contact with cellulose acetate (15 min.) and slowly on the screen. Used on very thin acetate sheets, it is said not to produce wrinkling. It dries smoothly with great adhesion, and will resist scratching or other damage to the same degree as the acetate material. Free-flowing properties, required for roller coaters that feed from a reservoir, can be provided by use of a special thinner, according to the company.

Flame-retardant epoxy

Availability of a new flame-retardant epoxy resin for hot-melt castings and dry lay-up laminating systems has been announced by Union Carbide Plastics Co. Combined with aromatic amine or anhydride hardeners, the new epoxy, designated Bakelite ERL-0625, forms cured systems with properties similar to those of conventional diglycidyl ether of bisphenol-A epoxies. Anhydride hardeners give the best high-temperature stability, the company claims.

Semi-solid at room temperature, the new resin requires only moderate heating to become a readily pourable liquid. It is usually warmed to about 130° F. for casting systems, and to 150 to 155° F. for laminating glass reinforced systems.

For both casting and laminating, ERL-0625 is handled and cured in essentially the same way as corresponding diglycidyl ether of bisphenol-A systems. However, in most cases, ERL-0625 systems take somewhat longer to gel and develop lower exotherms than other epoxy systems.

Decorative vinyl finishes

Multi-color, spray-on vinyl finishes for consumer, architectural, and industrial products have been introduced by Metal & Thermit Corp. In a two-step system, decorative vinyl finishes with controllable texture can be applied to either phosphated steel or aluminum by **(To page 219)**

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. . . to guide you in selecting or developing the best plasticizing system for your product, your process, or your plant.

Monsanto's Plasticizer Council staff aggregates more than 250 years of experience in the technology of plasticizing. They bring to bear a fully equipped special laboratory for complete, competent guidance for our customers.

When the key to solving your resin formulation, processing, or performance problem appears to be an improved plasticizer system, *your* know-how in plastics and *ours* in plasticizers can be teamed together for mutual advantages.

The user's best interest is always the objective of Monsanto's Plasticizer Council. This team of busy specialists selects plasticizers from the widest variety available anywhere, exercising great care to approximate customers' actual processing conditions. The Plasticizer Council can guide you to efficient one-, two-, or three-component plasticizer systems; can recommend a variety of extenders or secondary plasticizers to help minimize cost—*without restricting plasticizer selection to any one type or narrow group in which there is a vested interest.*

It pays to consult the Plasticizer Council. You can quickly obtain these valuable services—along with the industry's most diversified line of quality plasticizers (*more than 80!*)—by contacting one of the following offices of Monsanto Chemical Company: ATLANTA 9 (*TRinity 6-0777*) • BOSTON 49 (*DUnkirk 7-5010*) • CHICAGO 11 (*WHitehall 4-6750*) • CINCINNATI 6 (*WOodburn 1-3677*) • CLEVELAND 15 (*SUperior 1-3830*) • DETROIT 23 (*BRoadway 3-7090*) • HOUSTON 5 (*JAckson 6-2551*) • LOS ANGELES 22 (*RAymond 3-2493*) • MINNEAPOLIS 2 (*FEderal 9-4651*) • NEW YORK 22 (*PLaza 9-8200*) • PITTSBURGH 28 (*LOcust 3-4010*) • ST. LOUIS 66 (*WYdown 3-1000*) • SAN FRANCISCO 4 (*YUkon 6-6232*) • SEATTLE 4 (*MAin 2-4203*) • SYRACUSE 3 (*GRanite 4-6001*) • WILMINGTON 3 (*OLympia 8-6423*)

How Monsanto's nearby bulk storage and rapid shipping service can save you worry and money

SAVE ON MATERIALS HANDLING

Bulk-storage tanks installed at your plant can greatly reduce your materials-handling expenses: *lower labor costs and virtually no material spillage.* Monsanto can help you design your bulk-storage facilities and offer suggestions on their successful operation.

SAVE BY MIXED SHIPMENTS

Bulk or mixed-carload shipment prices average 10% below LTL or LCL costs. Two or three plasticizers, shipped in compartmented tank trucks or tank cars, are each billed at the tank truck or tank car rate. Any combination of drummed plasticizers may be shipped at the full truck or carload rate.

FAST DELIVERY

Your orders receive our prompt attention, *and we always strive to meet your delivery requirements.*

SUPPLIES ARE NEAR

Monsanto can ship tank trucks, tank cars, or carloads of most plasticizers from shipping points strategically located near every major plastics-manufacturing point. Producing plants at East St. Louis, Ill.; St. Louis, Mo.; Everett, Mass.; Long Beach, Calif.; and Anniston, Ala. Additional bulk storage at Akron, Ohio; Greensboro, N. C.; Houston, Texas; Miami, Florida; and Perth Amboy, N. J. Also 14 more warehouses blanket the nation for fast-delivery shipments.

CHEMICAL MATERIALS CATALOG, *page 432, gives technical and shipping information on forty Monsanto Plasticizers.*

How SANTICIZER® 409 gives vinyl products high-priced properties at the lowest cost of any premium polymeric plasticizer

PERFORMANCE: SANTICIZER 409 *stays put.* Its compatibility-stability is superior, under highly humid conditions, particularly when formulated with heat-stabilizing epoxy plasticizers. SANTICIZER 409 stubbornly resists migration to polystyrene—and to both natural and synthetic rubbers—as well as extraction by solvents. Stability to light and heat is exceptional. There's hardly a trace of odor or color.

PROCESSING: The good solvating action of SANTICIZER 409 can boost your output, too. Promotes fast fusion and extrusion. Helps prevent "fisheyes," roughness, and pinholes.

PRICE: SANTICIZER 409—*at 4¢ to 6¢ per lb. LESS than other premium-quality polymerics*—imparts top-quality performance to many kinds of vinyl products.

PROOF: Try it . . ."on paper," in the laboratory, in the plant. Compare SANTICIZER 409 with *any* other polymeric plasticizer (price, properties, stability, ease of processing). You will see that SANTICIZER 409 gives *more profit per unit volume of vinyl compound.*

FACTS: Technical Bulletin PL-409 gives complete performance data—including specific details on how SANTICIZER 409 can help you make:

- **105° wire compound with exceptional electrical properties and retention of elongation.**
- **permanent, adhesive-backed film.**
- **migration-resistant, low-odor refrigerator gasketing.**

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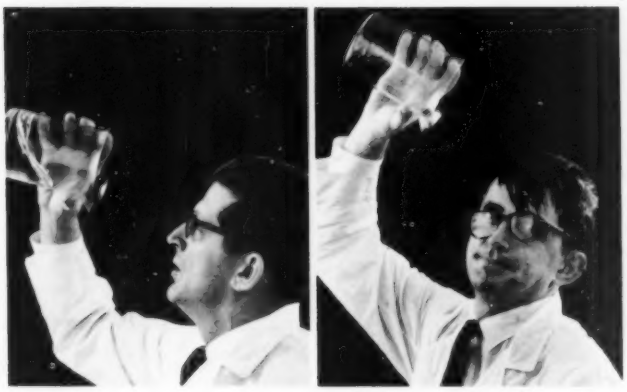
How MOD-EPOX® liquefies viscous epoxy resins and "liquidates" some of the cost



PERFORMANCE: Reactive MOD-EPOX reduces epoxy resin viscosity as much as 75%, combines *chemically* in the curing to become part of the resin. This means you can use more filler, yet have faster flow, less entrapped air, fewer rejected finished parts. And final properties are actually *improved:*

FLEXURAL STRENGTH OF 4-PLY GLASS FIBER-EPOXY LAMINATES (ASTM D638)

FORMULATION:	Control	with MOD-EPOX
MOD-EPOX	—	25
liquid epoxy resin	100	100
diethylenetriamine	12	8
magnesium oxide (fluffy)	—	0.25
FLEXURAL STRENGTH:	**psi**	**psi**
original	42,400	48,400
ketone—40 hrs. @ room temp.	42,400	47,700
water—40 hrs. @ 100°C.	29,400	37,600
10% caustic—27 hrs. @ 100°C.	8,500	9,200

Epoxy resins modified with MOD-EPOX for better flow and lower cost show better dimensional stability—lower power factor—equivalent hardness—and higher adhesive strength (*shear bond strength of a standard epoxy adhesive increases more than 50%, steel-to-steel*).

ECONOMY: NOW . . . MOD-EPOX at 36¢/lb.* costs less than any grade or brand of epoxy resin, 50-75% less than most other modifiers . . . AND reduces the curing-agent requirements to about ⅔ of usual amounts.

FACTS: Technical Bulletin PL-313 gives complete performance data—including specific details on how MOD-EPOX can help you make:

- **easy-handling electronic potting compounds.**
- **low-cost auto-body-solder formulations.**
- **high-strength casting and encapsulating compounds.**
- **tenacious adhesives for metals and glass.**

*T/L and C/L, F. O. B. Monsanto, Illinois

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☐ **Technical Bulletin PL-409** on SANTICIZER® 409 . . . more-for-the-money polymeric plasticizer

☐ **Technical Bulletin PL-313** on Monsanto MOD-EPOX® . . . key to better, lower-cost epoxy resins

☐ **Technical Bulletin PL-160** on SANTICIZER® 160 . . . quick-fusing, stain-resisting phthalate ester

☐ **Technical Bulletin PL-306** . . . tells how Monsanto AROCLOR® Plasticizers impart high resistance to flame and chemicals at low, low cost

☐ **Technical Bulletin PL-327** . . . tells how to formulate better protective coatings with Monsanto plasticizers

☐ **Technical Bulletin PL-314** . . . tells how to save time, labor, and material expense in the bulk handling and storage of Monsanto plasticizers

How SANTICIZER® 160 speeds processing and cuts costs of nonstaining PVC film and sheeting

PERFORMANCE: No other plasticizer can make film, sheeting, and floor covering so *STAIN-SAFE*—virtually impervious to asphalt, tar, grease, mustard, catsup, coffee, and other stainmakers. SANTICIZER 160 (butyl benzyl phthalate) also imparts toughness, high gloss, *and outstanding tear strength and dimensional stability.*

PROCESSING: Quick-fusing SANTICIZER 160 speeds Banbury mixing, milling, and calendering—*at lower processing temperatures.*

ECONOMY: SANTICIZER 160 is one of the lowest-priced primary plasticizers for vinyls. With its high tolerance for fillers and its high compatibility—*150 PHR for poly(vinyl chloride), 75 PHR for poly(vinyl acetate)*—it offers compounders savings on material, savings on formulation.

"TAILORED" BLENDS: In large-volume applications, when several plasticizers are used together in a fixed ratio for optimum performance, Monsanto can usually *custom blend* them to your specifications . . . to reduce your storage-facility requirements; eliminate mixing error or variation; and reduce inventory requirements, ordering costs, and production expense.

FACTS: Technical Bulletin PL-160 gives complete performance data—including specific details on how SANTICIZER 160 *also* can help you make:

- **lower-cure-temperature plastisols and organosols.**
- **high-gloss, water-resistant lacquers.**
- **economical vinyl chloride-vinyl acetate emulsions.**

MAIL THE HANDY COUPON NOW

THE PLASTISCOPE

(*From page 214*)

conventional or electrostatic spray techniques, according to D. W. Oakley, v-p and manager of the Coating Division. He added that this new system permits application of a tough multi-colored vinyl finish to products after fabrication. Since forming and welding are done before the finish is applied, no special care is required in fabrication. The different colors and textures are obtained merely by changing the vinyl spray material, and coated rejects can be stripped and resprayed. Since production scrap is generated prior to coating, no vinyl material is lost and the scrap metal has full value.

The resin used is a combination of various vinyl chloride materials. Work is now under way to develop a single application system to avoid separate applications of base coat and top coat. The new method would use a gun that mixes colors at the nozzle.

Dip dyes for plastics

Cold dip dyes that can be used on most plastics have been announced by Midwest Technical Service, Downers Grove, Ill., under the designation 200 Series. The dyes are offered in five basic non-shifting golds. It is expected that vacuum metallizers will use these dyes to convert aluminum colors to brass or gold.

The 200 Series is ready to use, and requires no heating or mixing. The dyes are used where uniform transparent colors are required; which is often difficult to obtain by spray techniques.

Color concentrate for polypropylene

Color-Pak, a custom-matched concentrate system for Escon polypropylene, which is designed for use by molders who desire end-product custom color matches at a minimum cost, is now available from Enjay Chemical Co., New York, N. Y.

The masterbatch color concentrates are blended with natural Escon before use in the ratio of 1:10. Most present Escon grades are adaptable to the system. Color-Pak base prices are dependent upon pigment requirements and grade of natural resin used.

For improved rigid urethane

A silicone additive that facilitates production of improved polyurethane foams has been announced by Dow Corning Corp. Named Dow Corning 113, the additive is said to offer excellent stability, in storage, in all systems; less sensitivity to flame retardants, viscosity, and color stabilizers, and to variations in mixing; and ease of handling and mixing.

Commercially available in unlimited quantities, the new additive is a silicone-glycol copolymer. Its function is to promote formation of uniform, fine-celled, rigid polyurethane foam. It is used at concentrations from 0.3 to 0.8% based on total weight.

Paper-PE bond

A nonflammable adhesive, which permanently bonds paper labels to treated and untreated polyethylene containers, has been developed by Java Latex & Chemical Corp., New York, N. Y. Called Polylabel Adhesive, this water-based compound can be applied by the New Jersey Pony Labelrite, as well as Shaeffer, Potdevin, and other standard labeling machines, according to Java Latex.

The new adhesive is said to make labeling on rigid, semi-rigid, and flexible polyethylene containers fast and economical, and eliminate the need for expensive silk screen printing and pressure-sensitive labels which must first be separated from a release paper. Polylabel is recommended for labeling PE jars, bottles, and squeeze tubes. It is available in 55-gal. drums and in 1- and 5-gal. containers.

Release paper

A new release paper, called Stick-Not, claims to solve handling problems for products with surfaces that tend to stick together. A sturdy, high tear-strength paper, it is said to be suitable for floor tiles, wall coverings, shelf linings, labels, tapes, and decals. It won't cause transfer of adhesives and silicones. Stick-Not can be easily die-cut, or printed on the untreated side, according to the producer, Crocker, Burbank Papers Inc., Fitchburg, Mass.

Polyethylene latex

Spencer Chemical will build a plant in Chicago, Ill. to polymerize ethylene into a latex form that may be used in polishing waxes; in wash and wear fabrics to give "hand" or a softer feel, and as sizing in paper. PE emulsions have been on the market for a long time, but the new material is said to have a much higher molecular weight than the type generally used in waxes or finishes; and, therefore, will be more durable, according to Spencer technicians. Yet it will sell at approximately the same price. The Spencer material will also be adaptable to other latex systems.

Pressure-sensitive PE tape

A new pressure-sensitive polyethylene tape, which is expected to become a household, commercial, and industrial commodity, and exceed the range of applications previously associated with cellophane tape, is announced by Fasson Products, Painesville, Ohio, a division of Avery Adhesive Products Inc. It is suggested for taping freezer packaging, household repair and protection, closure and sealing of plastic covers and liners, drums, bags, tarpaulins, etc., waterproof coating or sealing, corrosion protection of piping, as well as sealing seams in concrete forms.

The tape is stretchable, conforms to most surfaces and contours to which it is applied, and is extremely resistant to water, many chemicals and solvents, the company states. The tape performs effectively at temperatures from −50 to 225° F.

Vinyl copolymer emulsion

Availability of a new vinyl copolymer emulsion, which possesses a high degree of inherent tack and adhesion to specific surfaces, has been announced by Shawinigan Resins Corp., Springfield, Mass. Designated Resin D-845, the new emulsion reportedly provides clear, soft, non-re-emulsifiable films and is compatible with borax and various organic solvents.

The material is suggested for use in adhesives formulations, particularly those for pressure-sensitive and contact adhesives. The permanent dry tack and outstanding adhesion of the material make it suitable for bonding difficult surfaces such as polyethylene and polypropylene. Resin D-845 is also suggested for use as an agent to modify heat seal temperature, tack, and flexibility of standard polyvinyl acetate emulsions.

Styrene and acrylate emulsion copolymers

The first three in a new series of water-emulsion copolymers of vinylpyrrolidone are available, in developmental quantities only, from Antara Chemicals, a division of General Aniline & Film Corp., New York, N. Y. Tradenamed Polectron, this series represents the company's entry into water-emulsion polymers.

The three copolymers are Polectron 130—a vinylpyrrolidone/ethyl acrylate copolymer emulsion; 430 and 450—vinylpyrrolidone/styrene copolymer emulsions. Each has a 40% solids content.

Features claimed for the water-emulsion polymers are emulsion sta-

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VYN-EZE for Polyvinyl

combination slip and anti-block additive for films, sheeting and tubing. VYN-EZE produces greater efficiency and speed in the winding, handling and converting of Vinyls – gives you a new standard for improved clarity along with anti-tacking characteristics. FDA APPROVED.

STAT-EZE for Nylons, Synthetic blends and Wool

overcomes static accumulation on carpeting. Also recommended for undergarments, upholstery goods and dresses made from synthetic fibers. Easy to apply by spray, sponge or immersion. Tenacious and hard to rub off.

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THE PLASTISCOPE

(*From page 219*)

bility, dye receptivity, good adhesive and film-forming properties. Some of the properties inherent in the new emulsion polymers are due to their vinylpyrrolidone content. They are said to have excellent freeze-thaw stability, shear stability, acid and salt tolerance. They can be crosslinked by exposure to temperatures of 100° C. or higher for ½ to 1 hour.

All three are insoluble in water, ethyl alcohol, ethyl acetate, acetone, methyl ethyl ketone, benzene, carbon tetrachloride, heptane, and dioxane; except Polectron 430, which is partly soluble in benzene, and Polectron 450, which is partly soluble in water.

Tank car quantities are expected to be available before the end of 1961.

Aerosol anti-stick agent

A new formula for Fluoro-Glide, the company's aerosol-dispensed fluorocarbon lubricant and anti-stick agent, has been announced by Chemplast Inc., East Newark, N. J. The addition of a non-toxic oxide is said to improve the adhesion of the Teflon-like film to sprayed surfaces. Typical applications include surfaces of rolls, molds, dies, platens, etc.

Socony Mobil subsidiary offers to buy Kleemann Ltd.

An offer to acquire all the common and preferred shares of O.&M. Kleemann Ltd., British plastics processing company, has been made by Mobil Holdings Ltd., subsidiary of Socony Mobil Oil Co. The offer must be approved by the United Kingdom treasury and by the holders of not less than 90% of the shares of each class of stock. The Kleemann company employs about 700 people. If the deal goes through, Derrick Kleeman is expected to continue as managing director. Socony's outlay in this transaction reportedly would be approximately $20 million.

Lower price for p-tert-Butylphenol

A price reduction of 2¢/lb. on p-tert-Butylphenol has been announced by The Dow Chemical Co., Midland, Mich. Under the new schedule, prices will be 23½¢/lb. in tank car quantities, and 25½¢/lb. bagged in carloads. The quoted prices apply across the board on all quantities, freight allowed.

The major use of p-tert-Butylphenol is in the manufacture of phenolic coatings resins for products such as spar varnishes, floor varnishes, enamels, and electrical insulating varnishes. It also is used as an intermediate in producing anti-cracking agents for rubber formulations and anti-oxidants for a variety of end products.

More 2-ethyl hexanol

More than 15 million lb. of 2-ethyl hexanol will be produced by Enjay Chemical Co. as part of an expansion program that also includes manufacture of hexadecyl, C16 alcohol. The 2-ethyl hexanol will be sold primarily to phthalic esters manufacturers for production of DOP, a vinyl chloride plasticizer. The new production is a result of expansion of oxo alcohol facilities, at Baton Rouge, La., from 90 million to 120 million lb. annual capacity.

New price on Butenediol

A price reduction on 2-Butene-1,4-diol from 73¢ to 69¢/lb. in tank car quantities is announced by Antara Chemicals, a division of General Aniline & Film Corp. This is the second reduction in the last year from the original development price of $1.25.

Butenediol is a product of GAF's high-pressure acetylene plant in Calvert City, Ky. It is said to be the only commercially available olefinic glycol, and it is achieving increasing markets as an intermediate for polymers, specialty plastics and plasticizers, as well as other chemical products. As large-volume uses for this chemical grow, it is anticipated that Butenediol will be available in the 50¢/lb. range.

High temperature adhesive

The development of a new adhesive, said to have high electrical resistance and low thermal conductivity, that is suitable for use up to 1000° F., has been announced by Radiation Applications Inc., Long Island City, N. Y. It is expected to find important uses as a structural adhesive and also for coating and encapsulation of electronic components.

The new material is an addition to RAI's line of Raiseal 300 adhesives. These adhesives are 2-part systems that are said to remain unaffected by water, typical organic solvents, and hydraulic fluid.

Color for polypropylene

Polypropylene pellets with predispersed color are substantially more effective than dry, powdery pigments in achieving optimum coloration for polypropylene in molding and extruding operations, according to a report recently issued by Eastman Chemical Products Inc.

Eastman says that use of the pellets eliminates accumulation of color residue on the walls of tumbling barrels, thus permitting use of the same barrel

for producing a succession of different colors in the material.

The absence of residue, furthermore, makes it unnecessary to clean the feeding apparatus, the hoppers and other machine parts that come in contact with the concentrates with each change of color. An additional advantage is that air hopper loaders can be used to feed mixtures to the machines without danger of blowing pigment particles around that would contaminate other materials.

While Eastman supplies precolored as well as natural Tenite polypropylene, its polypropylene color concentrates are made available to molders and extruders who prefer to do their own coloring. The concentrates are furnished by Eastman Chemical Products from formulations already developed in its Tenite Color Laboratory, or they can be custom-blended in a virtually limitless array of colors and color effects.

FEP fluorocarbon in dispersions

Teflon FEP fluorocarbon resin, commercially available since Feb. 1960, can now be purchased as a dispersion or as formulated spray finishes, according to the Du Pont Co.

The dispersion, designated TE-9500 FEP, is said to provide low-permeability coatings, excellent heat sealability, high dielectric strength in thin films, and may be fused at lower temperatures than dispersions of the older Teflon TFE resins. Surface coatings of FEP dispersion, or impregnated fabrics or yarns containing FEP dispersion, can be sealed together, or to wire insulation, films, or massive shapes made from FEP or TFE fluorocarbon resins.

TE-9500 is a water-based dispersion containing 6½ lb. of finely divided FEP fluorocarbon resin solids per gallon. It is being test marketed by the Polychemicals Dept. of Du Pont at an introductory price of $12/lb. of solids when ordered in 30-gal. drums.

Southeast Asia shows interest in plastics

A growing interest in the utilization of plastics in Hong Kong, Taiwan, Viet-Nam, and Indonesia is indicated by an increasing number of requests for technical information on products used for the modern production of plastic products, according to A. A. Schwartz, president of Schwartz Chemical Co. Inc., Long Island City, N. Y., "Specific interest has been shown," Mr. Schwartz reported, "in data on dyes, lacquers, and coatings for metallizing of plastics." His company's promotion efforts have produced particular requests for technical data on

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THE PLASTISCOPE

(From page 221)

metallizing coatings for polystyrene, dyes for general plastics application, and glue.

TTP broadens activities

Tube Turns Plastics Inc., Louisville, Ky., U. S. pioneer in injection-molded thermoplastic piping products, has announced it will broaden its activities in the industrial plastics field with establishment of a plant at Garland, Texas, to make products of halogenated plastics. Carl B. McLaughlin, president of TTP, which is an affiliate of Chemetron Corp., Chicago, Ill., said production of standard shapes and custom molded thermoplastic parts will start in mid-May under the trademark Halochem. Initial output, he said, will be products made of (TFE) Teflon.

Sales manager for Halochem products will be George H. Hunt III, formerly manager of TTP's technical department in Louisville. Eugene Wilkes, formerly plastics production manager for the Murray Co. of Dallas, Texas, will serve as the production manager.

Halogenated thermoplastics are those having one or more of the four chemical elements called halogens—most often fluorine or chlorine—in their make-up. They are synthetic organic polymers generally characterized by high-temperature range, excellent resistance to chemicals and electrical non-conductivity.

Among raw materials used by TTP will be Teflon (Du Pont); Kel-F, (Minnesota Mining & Mfg. Co.); Halon (Allied Chemical Co.); and Kynar (Pennsalt Chemical Corp.).

To make polycarbonate sheet plate and rod

Cadillac Plastic & Chemical Co. has begun production at its suburban Detroit, Mich. plant of extruded polycarbonate shapes of General Electric's Lexan resin.

Supplies of sheet plate and rod will be rationed until Cadillac Plastic's 20 warehouses are stocked. Introductory prices will reportedly be about the same as those for Cadco Delrin acetal shapes, and slightly higher than the company's nylon line.

Cadco Lexan shapes are expected to find applications as ball and roller bearings, structural housings, hydraulic fittings, coil forms, electric and electronic insulators, and submersible drive mechanisms.

Lexan's transparency, unique among the mechanical thermoplastics, also make it especially suitable for explo-

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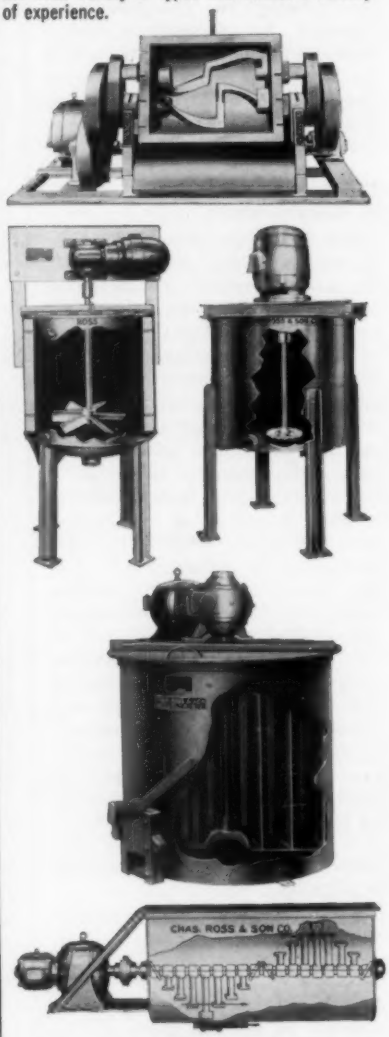

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sion-proof windows, acid-proof view plates, etc.

The firm will produce and stock sheets in thickness from ¼- to 1½-in. widths up to 12 in. and standard lengths of 3 or 4 ft., depending upon thickness, with special dimensions and lengths available on special order from the company.

More polyethers

Supplementing existing facilities at Austin, Texas, Jefferson Chemical Co. Inc. is now also producing polyethers for the urethane industry at its Conroe, Texas plant. The company expects to add new polyethers to the line, as new industry uses are developed for them. The polyethers are raw materials from which flexible, semi-rigid, and rigid urethane foams are produced.

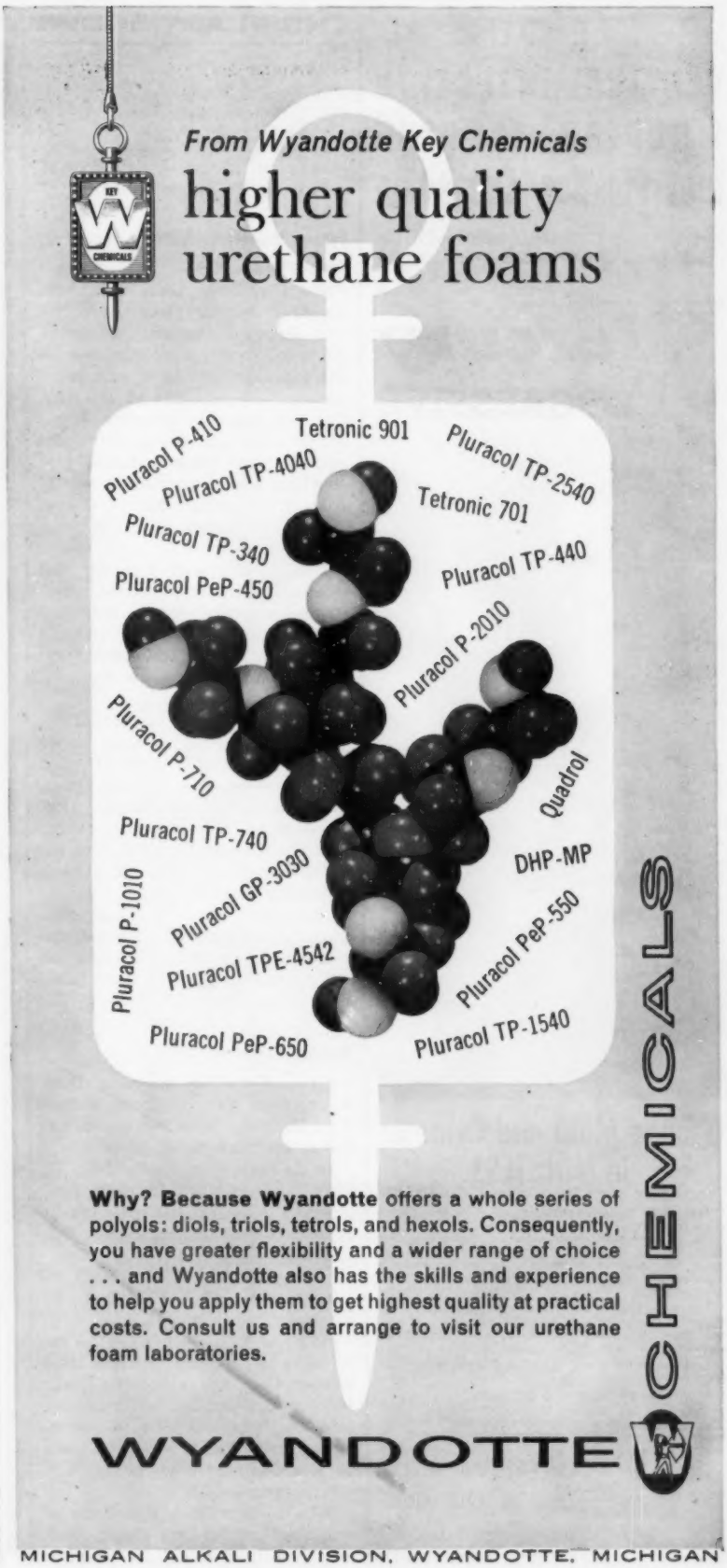
High-molecular polyether triols and and diols are widely used in the preparation of most flexible urethane foams. Lower-molecular-weight diols and triols produce more rigid foams. The versatility in the characteristics of urethane foams, produced by varying combinations of high and low molecular weight diols and triols, is one of their main attractions as a cushioning material, and also offers many opportunities for tailor-making of foams for specific applications.

Rigid foam systems

Three new systems for producing rigid polyurethane foams with excellent dimensional stability have been developed by Archer-Daniels-Midland Co. Other characteristics claimed for the foams include 90% or more closed cell structure, small and uniform cell size, non-friability, excellent adhesion, minimal toxic odor, and no shrinkage for free rise densities above 1.6 lb. per cu. foot. The foams are suited for commercial refrigeration, sound deadening, flotation in boats, special packaging, and truck trailer insulation. Basically, all three of these systems are two-component systems, incorporating the aging characteristics, reduced water sensitivity, and favorable economics of the polyethers.

ADM's Arothane 7825, low in viscosity to facilitate mixing, is used in the three systems. Arothane 7846 produces a low-density foam of 1.5 to 1.7 lb./cu. ft. when used in equal weight with Arothane 7825. Arothane 7846 contains an emulsifier and catalyst. Arothane 7845, similar to 7846, contains no foaming agent. It is designed for users who wish to add their own blowing agent. By varying the amount of foaming agent, densities of 2 to 10 lb./cu. ft. can be obtained.

Arothane 7847 is a low-catalyst version of 7845. Used with 7825 and varying amounts of a blowing agent, it produces foam with densities rang-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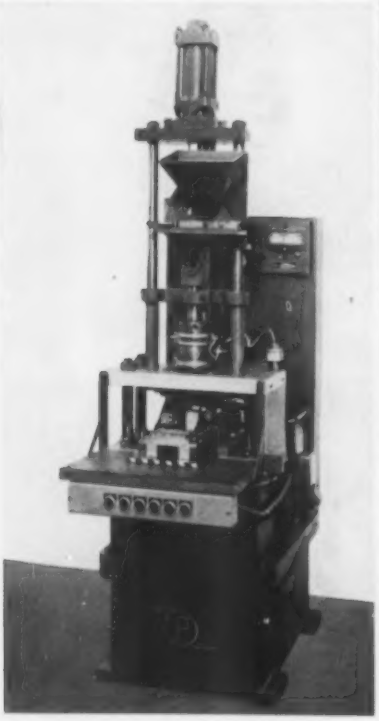

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THE PLASTISCOPE

(*From page 223*)

ing from 10 to 35 lb. per cu. foot. It also can provide extremely thick sections of low-density foams.

New companies

Trans-Plastics Corp., 6700 Morgan Ave., Cleveland, Ohio, has been formed to provide process industries with design, development, and fabrication of corrosion-resistant systems and components made of such materials as PVC, polyethylene, and ABS. The company also introduces a new line of pipe, pipe fittings, sheet, and tube made of these materials. One such item is being marketed as Shrink-Tube, PVC tubing which is said to have a contraction factor 50% its original diameter.

Trans-Plastics sees uses for this product initially for protecting above- and below-ground ferrous structures from electrolytic corrosion. Heading the firm are **Reuben Hitchcock,** president; and **Ted R. Stevenson,** v-p.

Panel Technology, P. O. Box 11304, St. Petersburg, Fla., has been formed to serve the reinforced fibrous glass panel industry, on a consultant basis, by **Anver S. Suleiman,** former vice-president of panel producer, Valco Inc. Panel Technology will maintain its own laboratory, and will publish a monthly technical letter.

According to Mr. Suleiman, "Secrecy in the panel field and a lack of dissemination of technical data has seriously handicapped the panel field's forward development."

Expansion

Amerace Corp. has announced plans to purchase, for cash, **Swan Rubber Co.,** Bucyrus, Ohio, subject to approval by Swan shareholders.

In its fiscal year ending July 31, 1961, Swan expects sales of approximately $22,700,000 and net profit of approximately $3,500,000 before federal taxes on income. Present Amerace divisions had sales of $27,700,000 and net profit of $3,255,000 in the fiscal year ended Dec. 31, 1960.

Amerace Corp. consists of seven divisions that include **American Hard Rubber Co.; Ace Comb Co.; Ace Bowling Co.,** (bowling balls); **Electric Mfg. Co.,** (multi-colored plastic moldings); **Gavitt Wire & Cable Co.;** and **Supplex Co.,** (plastic garden hose and custom compounds).

Swan Rubber Co. is a producer of mechanical rubber and plastic products, such as garden hose; hose for

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Engineers who can fill these positions must combine original thought with solid training in the basic physical sciences. They must be able to combine the reasoning of several disciplines in the development of a solution. Minimum requirements include:

★ Bachelor's Degree in Chemistry, Chemical or Mechanical Engineering.

★ Strength in one or more of the following fields: plastic and rubber compounding and fabrication techniques, chemical processes or subminiature transformer and toroid production.

These are responsible positions for engineers who are qualified to do original and creative work, and who can demonstrate by a record of past professional accomplishment that they possess this ability. Ours is one of the nation's most vital industries. We offer unusually generous company benefits in a Midwestern community which is famous for its beauty and low cost of living. All replies will be strictly confidential.

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All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

The Bendix Corporation
KANSAS CITY DIVISION
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appliances; plastic grips; plastic and metal wheels; and extruded rubber and plastic products of many varieties.

Container Corp. of America, Chicago, Ill., has purchased a 145,000-sq.-ft. plant in Los Angeles, Calif., from **Cal-Dak Co.,** to manufacture rigid plastic containers and other custom-molded packaging materials for foods, household products, and other consumer items. Before its purchase by Container Corp., the Los Angeles plant was operated by the **Plas-Tex Div.** of Cal-Dak. All Plas-Tex production employees have been retained. The newly purchased plant has injection molding equipment capable of producing 5 million lb. of plastics products annually. In 1958, Container Corp. entered the plastics packaging market with the acquisition of Garmold Plastics Co.

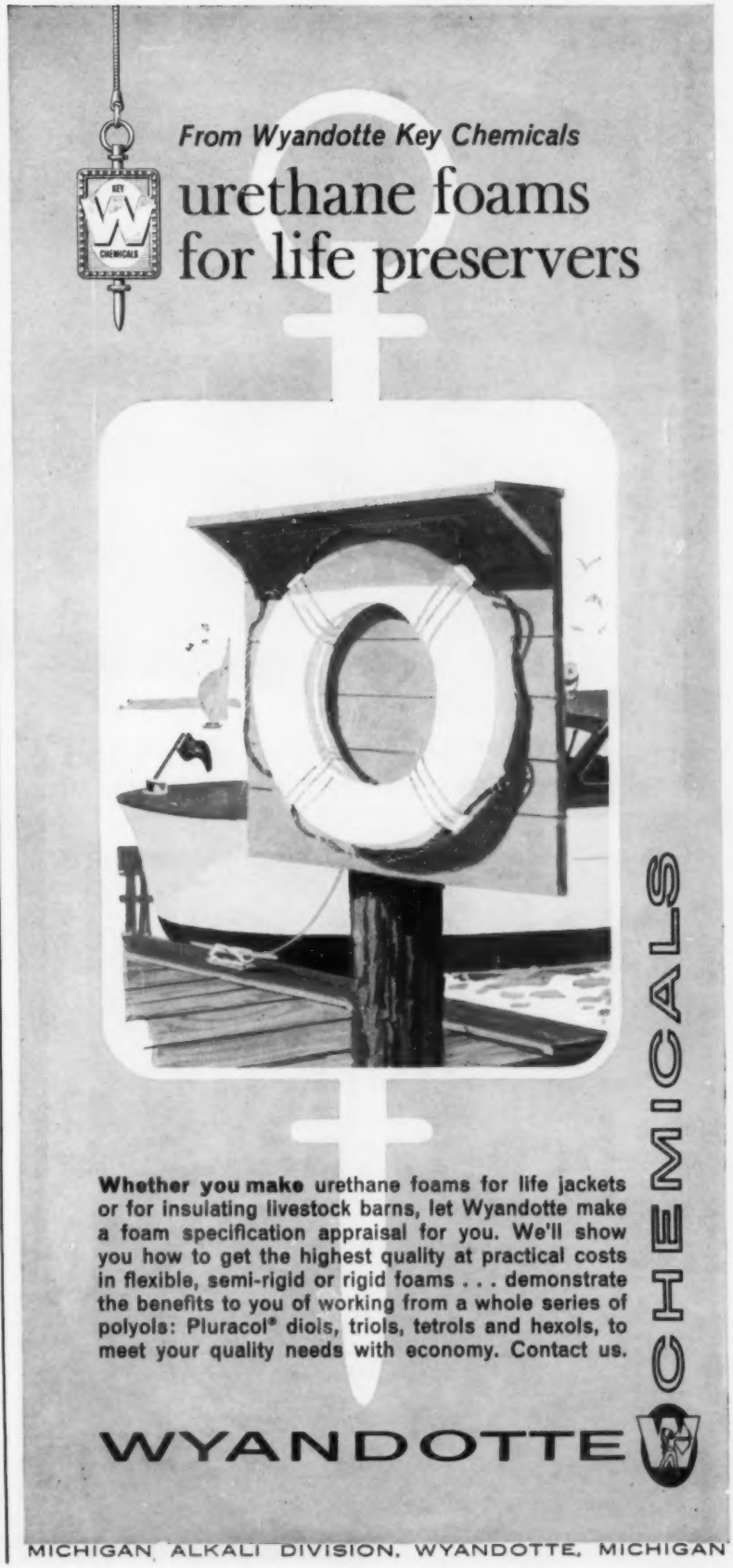
Brilhart Plastics Tool & Die Corp., a division of **Brilhart Electronics Corp.,** has acquired the Glass Div. of **United States Glass & Chemical Corp.** The name of the division has been changed to **U. S. Glass Co. Inc.** U. S. Glass operates two plants, one in Tiffin, Ohio and another in Glassport, Pa., with total manufacturing space of approximately 400,000 sq. feet.

National Vulcanized Fibre Co. has merged with **Fisher Mfg. Co. Inc.,** Hartwell, Ga. supplier of reinforced plastics as well as other materials-handling receptacles for the Southern textile industry.

Fisher is the second acquisition by National Vulcanized Fibre Co. within the past year and a half. In 1959, National acquired Parsons Paper Co. of Holyoke, Mass.

Allied Chemical Corp. is constructing a three-story office building at Morristown, N. J. The structure will be occupied by engineering and administrative personnel of various divisions and will be completed by mid-1962. This further step in the planned utilization of the Morristown site will raise company employment to approximately 1300 people. In Sept. 1960, the company announced plans for the construction at Morristown of 50,000 sq. ft. of additional building space which provides for the erection of a research laboratory, a process laboratory and a warehouse and garage. These three buildings will be occupied sometime this summer.

Southwestern Plastic Pipe Co., Mineral Wells, Texas, has purchased all common stock of **Ken-Way Plastic Products Corp.,** Phoenix, Ariz. The name will be changed to **Southwestern Plastic Pipe Co. of Arizona.** Offi-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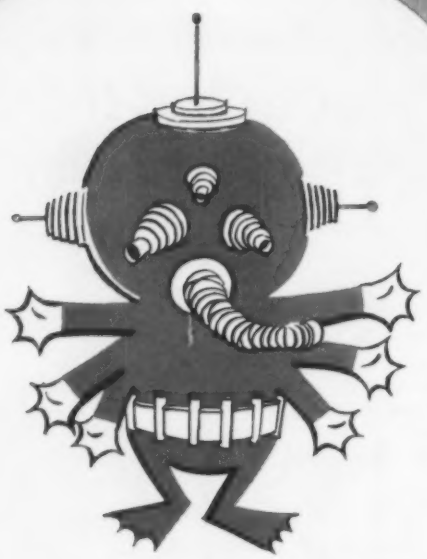

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CHEMICAL MATERIALS CATALOG Page 179

LUCIDOL DIVISION

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BUFFALO 5, NEW YORK

THE PLASTISCOPE

(*From page 225*)

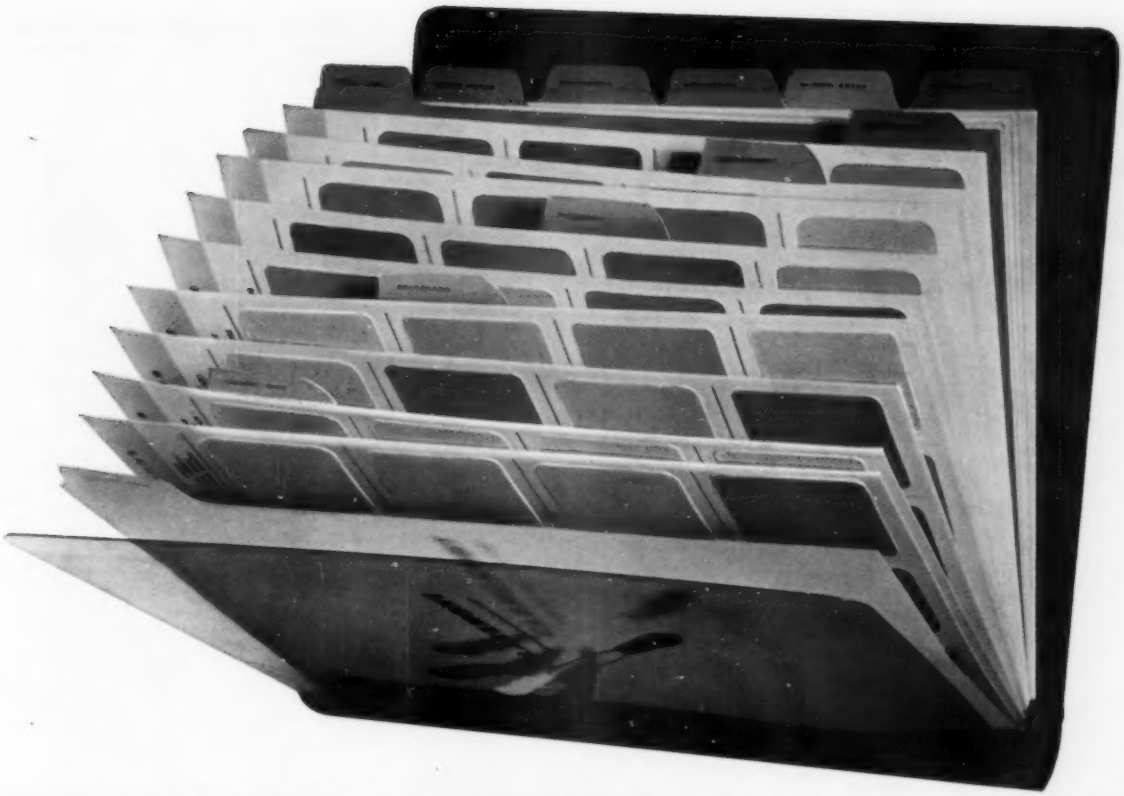
cers of the Texas firm will assume similar positions in the new company. They are **E. F. Clemens,** president; **Eugene C. Clemens,** 1st vice-president; **J. F. Bailey,** executive vice-president; and **E. W. Hendrick,** secretary and general manager. **M. B. Crawford Jr.,** who has been associated with Ken-Way since 1958 in its management and as part-owner, will continue in charge as active manager of the Phoenix corporation.

Southwestern Plastic Pipe Co. offers a complete line of both flexible and semi-rigid plastic pipe, including polyethylene, PVC, ABS; sewer and drain pipe, and electrical and communications conduit.

Southern Clays Inc., New York, N. Y., has opened a new research laboratory and pilot plant located on a 90-acre site near Gordon, Ga., about one mile from the main plant. The 16,000-sq.-ft. laboratory is subdivided into five main groupings; functional research, ceramics, paper, new product development, and organic applications—primarily rubber, plastics and paint.

Owens-Illinois has awarded a contract for the construction of a 62,000-sq.-ft. warehouse, to adjoin the Closure & Plastics Div. plant in Chicago, Ill. Enlarging operations of the blown plastic bottle plant has created the need for additional warehouse space. Completion of the one-story building is scheduled for September. O-I will produce blown plastic bottles at new facilities in St. Louis, Mo. and San Jose, Calif. by midyear. O-I also operates blown plastic bottle plants at St. Charles, Ill.; Glassboro, N. J.; Kansas City, Mo.; Los Angeles, Calif.; Cincinnati, Ohio; and has a plant under construction at Jersey City, N. J.

Dow Chemical International Ltd. S.A. has awarded final contract for construction of a new polystyrene production plant in Leghorn, Italy to **Foster Wheeler Italiana** of Milan. The plant will consist of polymerization units, coloring facilities, quality control laboratories, and technical service facilities. The plant will be operated by **Dow Chimica Italiana S.p.A.,** a wholly-owned Dow subsidiary, and will manufacture a wide range of Styron formulations. Completion of initial production capacity is scheduled for mid-1962. Total capacity is expected to reach 16,000 tons per year. **Raymond Duddleston** is project manager for the new unit with responsibility for **(To page 228)**



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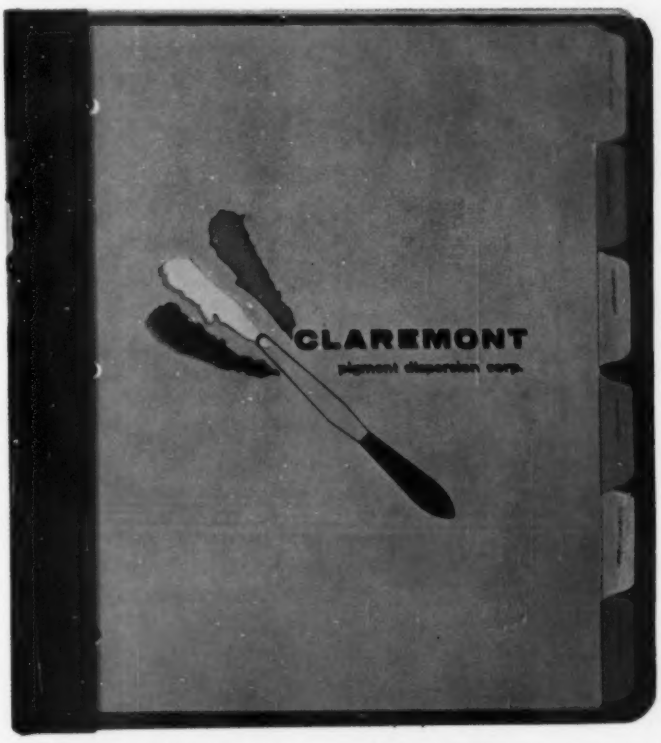

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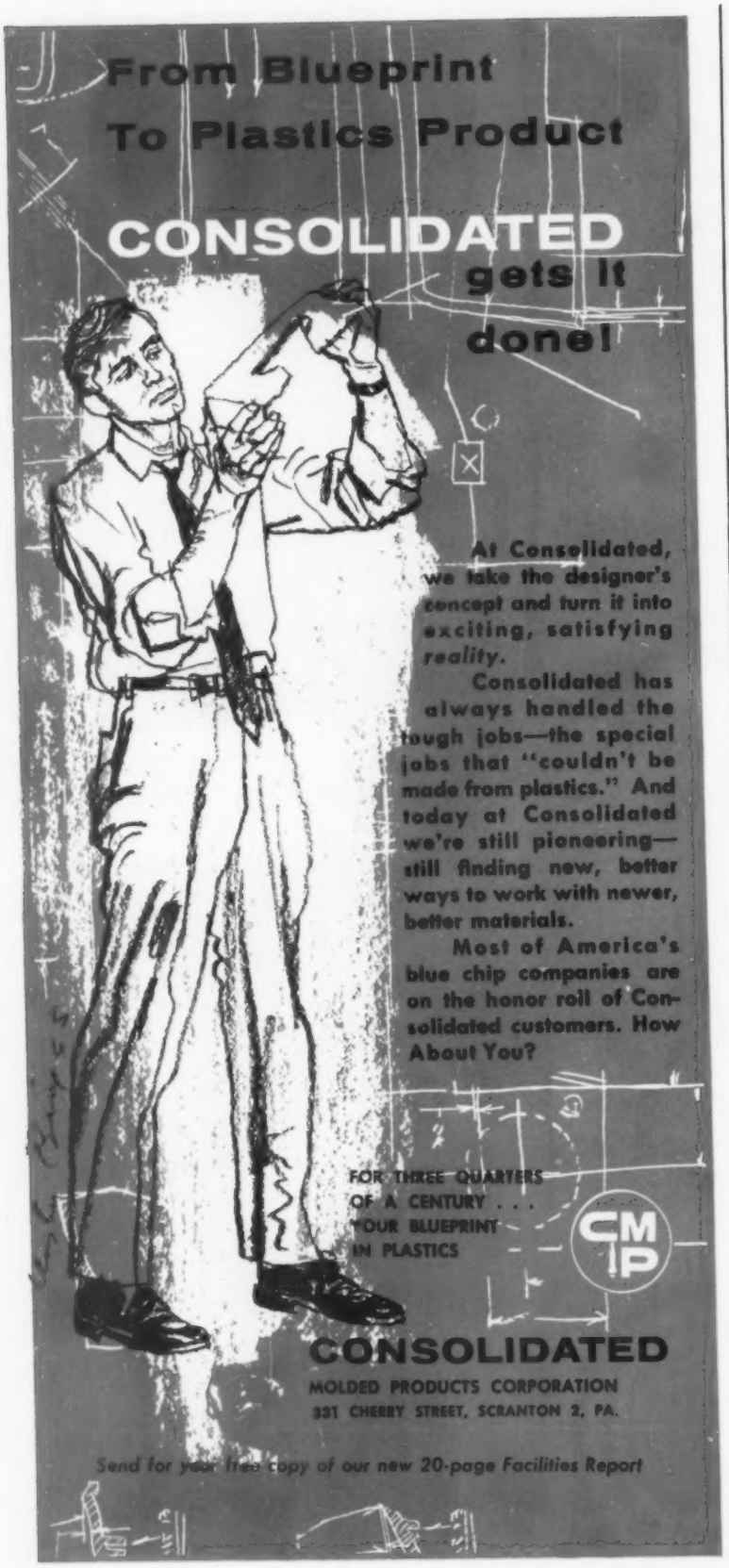
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THE PLASTISCOPE

(*From page 226*)

supervision of engineering, construction, and start-up operations.

Resisto Chemical Inc., Wilmington, Del., has acquired **Transpolymer Corp.,** Norristown, Pa. Transpolymer will be operated as a subsidiary of Resisto under the direction of **John E. Hampford,** vice-president, and says it will continue to manufacture acrylic resins, methacrylate monomers, polymers, and perform custom synthesis. Resisto plans to utilize certain Transpolymer equipment for producing some of its coatings and to use Transpolymers' basic resins for certain of its manufacturing requirements.

Rexall Drug & Chemical Co. has established its first major plastics processing plant in Europe with the purchase of a modern 200,000-sq.-ft. plant near Brussels, Belgium, for the manufacture of Tupperware products and IMCO containers and bottles. The plant, in operation this fall, will serve the European Common Market.

Tonka Toys Inc., Mound, Minn., has purchased **Empire Plastics,** Loretto, Minn. injection molder and producer of plastic parts for Tonka Toys. Empire will operate as a division.

Coming events

Plastics groups

June 21-July 1: Interplas 61, 6th International Plastics Exhibition and Convention, Olympia, London, England.

July 17-21: Gordon Research Conferences on Elastomers, Colby Junior College, New London, N. H.

Sept. 22-Oct. 1: International Plastics Fair, Copenhagen, Denmark. Contact: Int. Plastics Fair Secretariat, 10 Puggaardsgade, Copenhagen.

Oct. 17-19: The Plastics Show of Canada, Canadian National Exposition, Toronto. Contact: W. B. Pryde, Show Manager, 481 University Ave., Toronto, Canada.

Other groups

July 10-14: 35th NHMA National Housewares Exhibit, McCormick Place, Chicago, Ill.

Sept. 5-8: American Chemical Society, Chicago Section, 11th National Chemical Exposition, International Amphitheatre, Chicago, Ill.

Oct. 18-20: Packaging Institute, 23rd National Packaging Forum, Biltmore Hotel, New York, N. Y.—**End**

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Organo Tin Compounds for the manufacture of highest quality finished products under extreme processing conditions. Barium - Cadmium Compounds for the manufacture of suspension and alkali free emulsion PVC. Other metallic stabilizers for special applications. Organic stabilizers to enhance the effectiveness of metallic stabilizers.

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Compounds for obtaining optimum dielectric properties in conveyor belts and floor covering.

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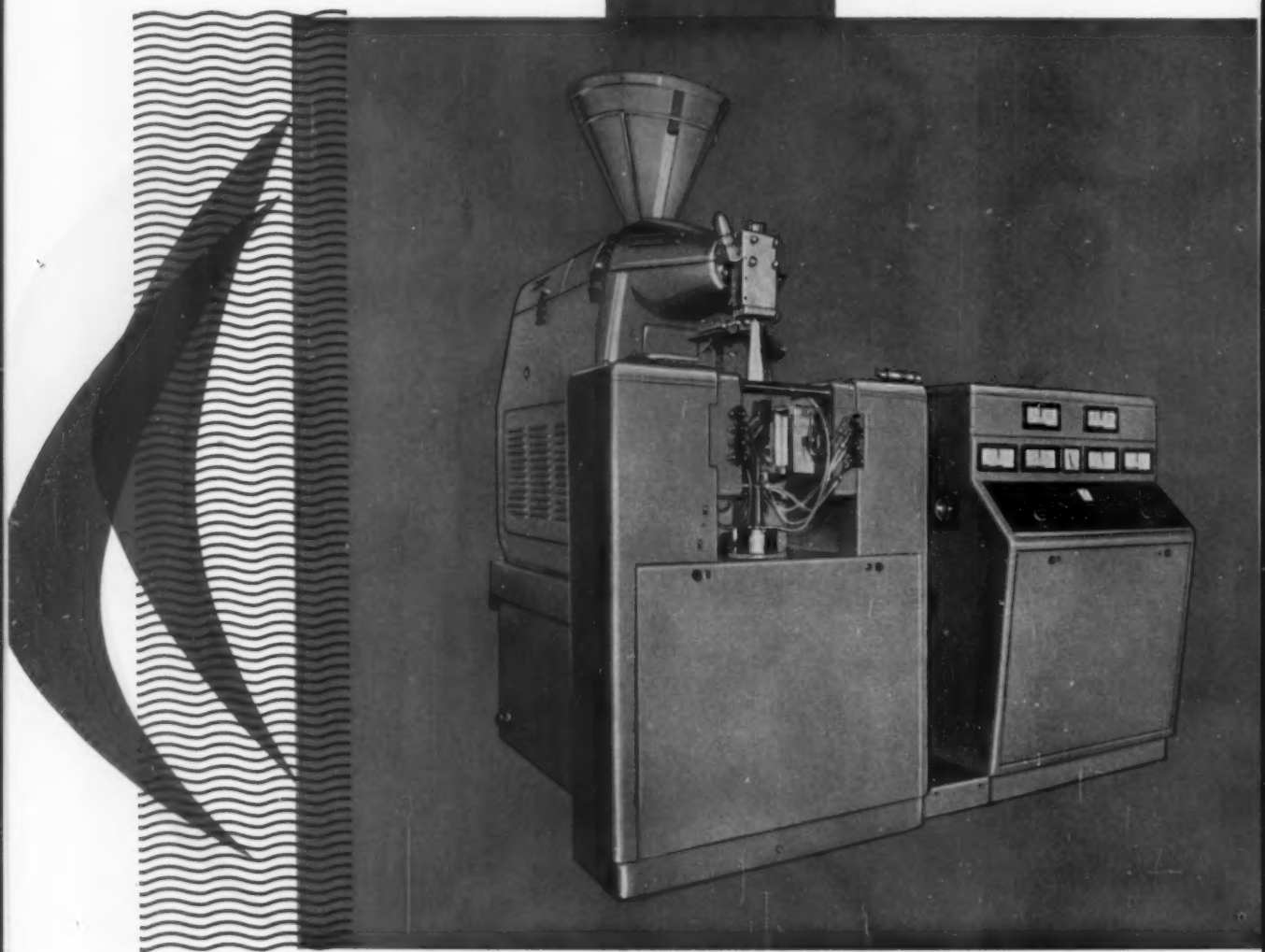

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It caused a rush of orders
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MODEL	300-145	2414-6	3214-12	3220-125 (A)	3220-125 (B)	3624-18
Max. Capacity-oz. (conventional)	14	9	16	16	20	24
Max. Capacity-oz. (with 2nd stage)		30	32	50	50	50
Clamping stroke (inches)	6-14	6-14	8-14	8½-20	8½-20	8-24
Daylight opening (inches)	32	32	36	42	42	50
Clamping pressure (tons)	300	250	375	375	375	450
Maximum Mold Size (VXH)	16½ x 28	14⅞ x 28	20 x 36	20 x 36	20 x 36	23¾ x 38

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COMPANIES...PEOPLE

Who's doing what . . . and where

The B. F. Goodrich Co., Akron, Ohio: **George B. Koch Jr.** named merchandising mgr. for **B. F. Goodrich Industrial Products Co.** He joined B. F. Goodrich Chemical Co., Cleveland, Ohio, in 1946 as sales promotion man. He became advertising mgr. in 1948, and served in that capacity until 1950, when he was assigned to organize an agricultural chemicals sales branch. In 1953, he was reappointed advertising mgr., responsible for public relations, sales promotion, and tech. literature. In 1959, he was named adv. mgr., commercial products, for the parent company.

G. Koch Jr.

George A. Mentzer, who succeeds Mr. Koch as advertising mgr., commercial products, joined the company in 1952. He was transferred to the advertising and sales promotion dept. of B. F. Goodrich Chemical Co., Cleveland, in 1954 and was named mgr. of trade advertising and sales promotion for that division of the company in 1960.

G. A. Mentzer

Allied Chemical Corp. — National Aniline Div.: Dr. Herbert C. Wohlers appointed to newly created position of dir., R & D chemicals and dyestuffs; **Herbert S. Hall** named asst. to v-p engineering and construction; **Edward T. Ramsey** appointed supv. purchasing, Moundsville, W. Va. plant; **Henry A. Cathey** named resident mgr., Charlotte, N. C. sales branch; **John K. Boykin** is Southeastern dist. mgr.; **Robert H. Keenan** transferred from Atlanta, Ga. to Philadelphia, Pa.

General Chemical Div.: John R. Edmonds named dir. production, and **Dr. Joseph Gordon,** tech. supv., polymer research section.

Solvay Process Div.: Dr. Elwood F. Booth Jr. appointed dir. research; **A. James Johnston Jr.,** assist. to mgr., organic chemicals section.

Harold E. Imes appointed pres., **Semet-Solvay Div.,** succeeding **Albert E. Scherm,** who retired.

Monsanto Chemical Co. — Plastics Div., Springfield, Mass.: **Chester L. Jones,** dir. of sales, resin products, promoted to asst. dir. of marketing. **Edmond S. Bauer,** product administrator, resins and coatings, promoted to replace Mr. Jones.

Chocolate Bayou Project, Alvin, Texas: **R. William Rotzler** appointed gen. supt. tech. services; **Hans G. Schleicher** named gen. supt. production; **William S. Sevier** appointed gen. supt. distribution.

Eastman Chemical Products Inc.: Lewis B. Connelly appointed dist. sales mgr., New York, N. Y. plastics sales office. **Joseph L. Reynolds** named to head the Dallas, Texas office of the plastics div. **Paul A. Aspy** named sales rep., Chicago, Ill. sales office of the plastics div.

Union Carbide Plastics Co.: Henry E. Allen, mgr. Vinyl Foam Div., has resigned, but will continue as a consultant on a part-time basis. **E. M. Muller,** who has been on the tech. staff of the Vinyl Foam Div., will be acting mgr. **E. Warner Emmens** named metropolitan New York regional office mgr.; **W. Warren Swenson** appointed a special rep., N. Y. sales region. **George H. Dougherty Jr.** appointed tech. rep., Midwestern sales region; **Thomas T. Spooner** assigned as tech. rep. for the South Atlantic sales region.

Union Carbide Olefins Co. has opened sales offices in Chicago, Ill. and in Memphis, Tenn. These are the second and third dist. offices established within the past year; the Cleveland, Ohio office has been in operation for several months. Products sold through these dist. offices include: acetylene, 1,3-butadiene, ethylene, calcium carbide, calcium hydroxide, calcium oxide, diphenyl, dicyclopentadiene, toluene, and unsaturated oils.

Catalin Corp. of America has formed **Macaw Corp.,** New York, N. Y., as a wholly-owned subsidiary to operate as distributor of plastics raw materials, including polystyrene, polyethylene, polypropylene, nylon, etc. This corporation will function independently of the parent company.

Riegel Paper Corp., New York, N. Y., has announced a realignment of operating divs.: A Flexible Packaging Div. has been established with **J. Hanes Lassiter,** v-p, named gen. mgr.; a Paper Div. has been set up to handle production and sale of industrial converting papers with **G. Lamont Bidwell Jr.,** v-p, as gen. mgr.; a Folding Carton Div. will handle production and sale of folding cartons primarily for the food field headed by **Chalmers W. Barr,** gen. mgr.

The Polymer Corp., Reading, Pa. mfr. of industrial plastics, has opened a regional office in Cincinnati, Ohio. **Stewart W. Tarkington** is dist. mgr. for plastic mill shapes and fabricated parts, sintered plastic parts, and molding resins. **Henry T. Brumleve** is dist. mgr. for the Whirlclad Div. coating systems. Polymer's line of Polypenco mill shapes, including nylon, Teflon TFE-fluorcarbon, and other thermoplastics are stocked and distributed throughout the territory by **Bearings Inc.** and **Dayton Plastics Inc.**

Missile Plastic Div. of H. I. Thompson Fiber Glass Co. has been created following merger of the company and **Dumont Mfg. Corp.** The new div., encompassing Dumont facilities in San Rafael and the HITCO Missile Plastic facility in Inglewood, Calif., will be headed by **C. S. Brown,** div. mgr.

Fedco Corp., Chicago, Ill.: **J. G. Tobin,** pres., elected pres. of **Plastic Houseware Mfrs. Assn.** The Chicago firm is a mfr. of plastics housewares.

Proven Products Div.: Stewart G. Price named marketing mgr.

Koppers Co. Inc.—Plastics Div.: R. F. Seubert, formerly mgr., applications laboratory, appointed mgr., product development. **J. G. Pick** succeeds him as applications laboratory mgr. **E. D. Shuster** succeeds Mr. Pick as mgr., technical laboratory.

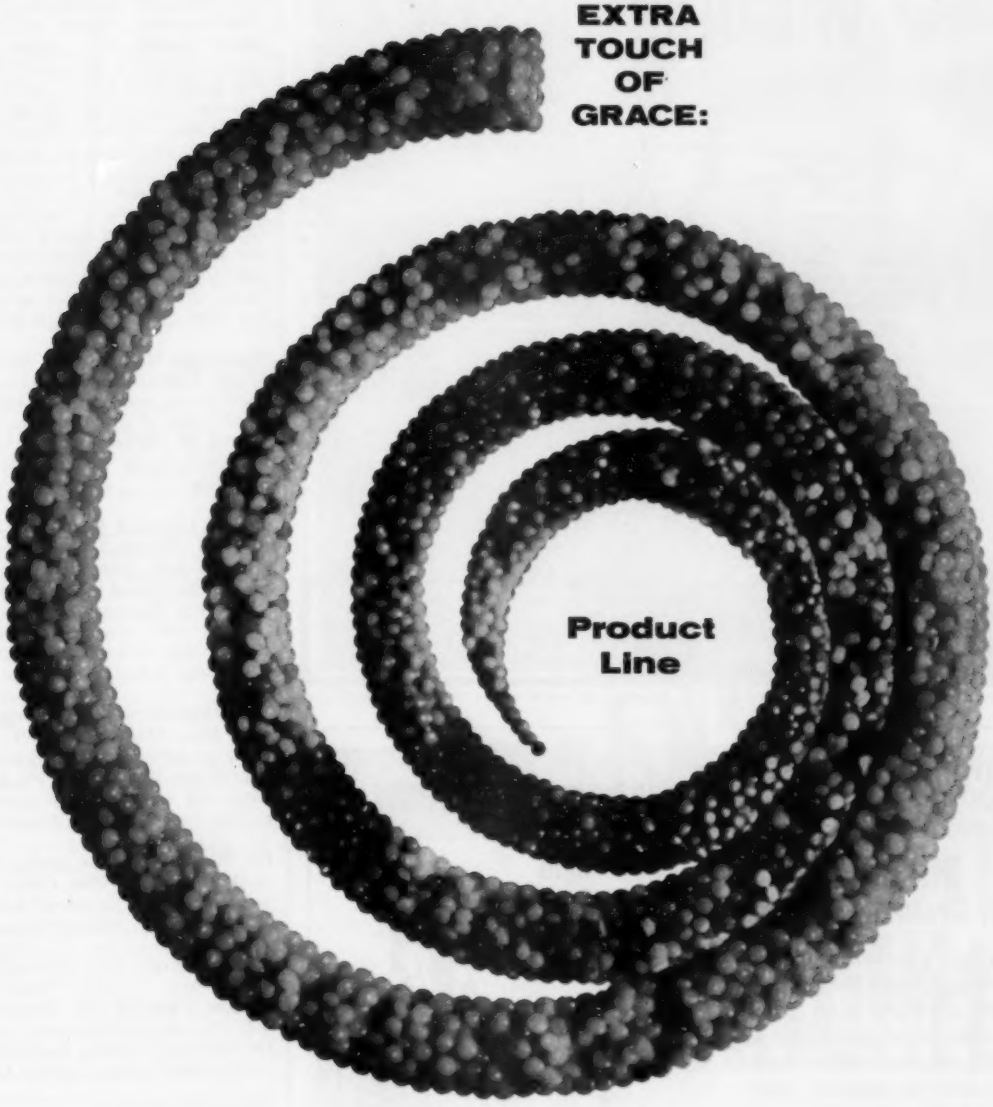
Randazzo Plastic Co. Inc., Los Angeles, Calif. injection molder: **A. G. Hartman** appointed v-p and gen. mgr.; **N. O. Hulsey** named sales mgr.

Glasply Corp. has moved from Mt. Vernon, N. Y., to Sixth St., Verplanck, N. Y., where the firm has established improved facilities for handling bag molding, press molding, premix, spray-up, and reinforced plastic tubing.

Air Reduction Chemical & Carbide Co.—Colton polymers dept.: **Robert C. Gilardi** appointed Western dist. mgr. with offices at City of Industry (near Los Angeles), Calif. **William F. Lehr** named Eastern dist. mgr. with offices at Union, N. J. **John V. Kaine** is Central dist. mgr. with offices in Cleveland, Ohio.

Pall Corp., Glen Cove, N. Y. mfr. of filters, porous plastics, and molded fibrous glass insulation materials, has announced a realignment of execs. to fill new posts in the company and its divs.: **Sidney Krakauer,** v-p of Pall, has become pres. of **Fibrous Glass Products Inc.,** Wilkes-Barre, Pa. **Henry Petronis,** v-p mfg. of Pall, has taken on added duties of pres. of **Hollinger Machine Co. Ltd.,** Montreal, Canada. **Joseph A. Whitwell,** formerly v-p sales, elected v-p sales development, Pall Corp., and will promote new prod- **(To page 234)**

THAT EXTRA TOUCH OF GRACE:



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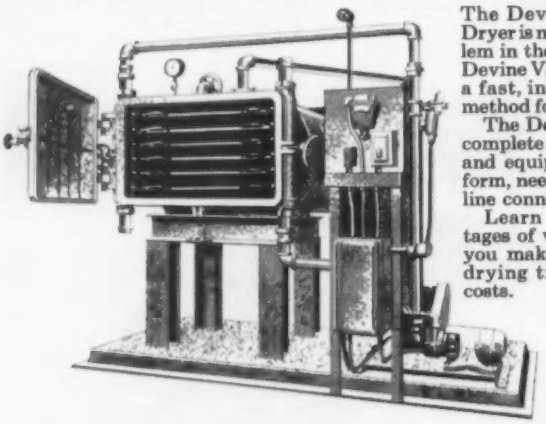

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The Devine Plastics Dryer is a complete unit, wired and piped and equipped with its own platform, needs only water and power line connection for installation.

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COMPANIES...PEOPLE

(From page 232)

ucts. **Charles H. Hacker,** formerly chief engineer, named gen. mgr. of **Micro Metallic Div.,** producer of industrial filtration equipment. **John A. Farris** promoted to mgr. sales and engineering liaison for **Aircraft Porous Media Inc.,** supplier of filters to aerospace industries.

Reeves Brothers Inc., New York, N. Y., has formed a new Fiber Div. for production and sale of staple, tow, and multifilament polypropylene. The new div. is also responsible for marketing polyethylene and polypropylene monofilaments and bristles.

Shawinigan Resins Corp., Springfield, Mass.: **Edward Lavin** named dir. of applications research; **Dr. Aubrey F. Price** is dir. of product research; and **Harold D. Weymouth** will serve as dir. of research administration and planning.

DeSoto Chemical Coatings Inc., Chicago, Ill.: **Richard J. Baruth** appointed regional sales mgr., Central region He will be located at the Chicago, Ill. sales office. **Thomas H. Lester** named regional sales mgr., with Southern region sales offices at Greensboro, N. C., and at Garland, Texas.

A. I. Massler, pres. of **Bestway Products Inc.,** Mountainside, N. J., is going to Africa on a mission for the Rockefeller Foundation. He will explore the possibility of producing plastics and records in Nigeria.

Dr. W. Paul Moeller named dir. of marketing for **AviSun Corp.,** Philadelphia, Pa. He succeeds **Henry E. Wessel,** who has resigned.

B. F. McAvoy, formerly tech. mgr., named asst. to v-p Plastics Div., **Spencer Chemical Co.,** Kansas City, Mo. He is succeeded as tech. mgr. by **Dr. Edward T. Severs,** formerly mgr., market development, AviSun Corp.

Thomas D. Tremmel appointed mgr. of the newly-opened Columbus, Ohio sales office of **Cadillac Plastic & Chemical Co.,** warehouse distributor of a variety of plastic sheets, rods, tubes, and films.

Zenas Crocker elected exec. v-p of **Nixon-Baldwin Chemicals Inc.,** Nixon, N. J. mfr. of thermoplastic sheetings.

Conrad G. Hurlimann joined **Geigy Chemical Corp.** as v-p and dir. He was previously admin. v-p and dir. of Pfizer International Inc.

E. J. Penberthy appointed rep. for custom molded plastics of **The General Industries Co.,** Elyria, Ohio.

Frederick A. Krone has been named tech. and marketing dir. of polyolefin

operations for **Foster Grant Co. Inc.**, Leominster, Mass.

William D. Chapman promoted from asst. sales mgr. to sales mgr., Chemical Machinery Div., **Baker Perkins Inc.**, Saginaw, Mich.

Jerald Sindelar joined the Color Div. of **Ferro Corp.**, Cleveland, Ohio, as asst. laboratory supv. in charge of the plastic dry color laboratory.

Delbert De Young appointed dir. of sales **Friesland Plastics Co.**, Friesland, Wis. producer of Tape-Seal brand Teflon tape for sealing threaded, flared, and compression joints.

Frank J. Teague, with the company since 1954, appointed v-p sales for **Sheffield Plastics Inc.**, Sheffield, Mass.

Harry L. Stephenson named Southwestern regional sales mgr. for **Ren Plastics Inc.**, formulator of epoxy tooling plastics. Headquartered in St. Louis, Mo., he will cover Texas, Louisiana, Arkansas, Missouri, Kansas, Oklahoma, and Southern Ill.

Robert S. Temple appointed to newly created post of sales mgr., plastics, for **Valchem**, div. of **United Merchants & Mfrs. Inc.** Initially, Mr. Temple will be responsible primarily for polyester resin sales.

Vernon Auten named supv., injection molding operations, for **Automatic Plastic Molding Co.**, Berkeley, Calif.

Donald J. Harrington joined the **Industrial Chemicals Div., Enjay Chemical Co.**, producer of chemical raw materials, olefins, and resins, etc. Enjay is a div. of the **Humble Oil & Refining Co.**

Charles W. Manzione appointed mgr., **Industrial Products Div., Claremould Plastics Co.**, Newark, N. J. injection molding firm.

Donald G. Van Tilburg named mgr. of **Socony Mobil Oil Co.'s** process promotion dept. in New York, N. Y. The process promotion dept. licenses mfg. processes developed by Socony Mobil, and handles sales of catalysts.

Charles H. Picard joined the Vinyl Plastics Div. of **Robeco Chemicals Inc.**, New York, N. Y. supplier of calendered and extruded vinyl film and sheet and corrugated vinyl panels.

George W. Prehler joined **Stauffer-Hewitt Inc.**, Franklin, N. J. producer of urethane foam materials, as mgr. of mfg. He was formerly plant mgr. of Stauffer Chemical Co.'s operations at Chester, Pa.

Correction

"Reinforced plastics missile components" (MPI, April 1961, p. 149): Pre-impregnated glass cloth (Mobaloy 815-D) is supplied by Cordo California Corp., Saugus, Calif.—**End**

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poly high impact strength with styrene flexibility

HIGH IMPACT 725.....is a polystyrene resin by Cosden that is extremely flexible, has good flow characteristics, plus excellent surface finish and gloss. H.I.725 was formulated as an economical resin for the toy market and other products with similar performance requirements. At your request a Cosden field representative will welcome the opportunity to discuss formulations relative to your molding requirements.

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Machinery and Equipment For Sale

FOR SALE—7 presses complete with central hydraulic system. Ideal for low pressure molding of reinforced plastics. Presses range in size from 113 ton to 226 ton with platens from 36" x 42" with 45" daylight to 52" x 76" with 65" daylight. Can be inspected and operated, equipment is in excellent condition, also 1 lab size Baker Perkins mixer for premix 6AN2 Model. Structural Fibers, Inc., 5th Ave., Chardon, Ohio—Phone AVenue 6-4118.

INJECTION MOLDING—HPM 9 oz; Hydraulic Press, French oil semiautomatic 100 ton; Mill-Farrell 16x36; Baker Perkins SS 100 Gal 2 Arm Jac. vac. Hyd. tilt 50 HP; 150 Gal Day Imperial Sigma; 3 Baker Perkins 100 Gal Sigma Jac. Hyd. tilt; SS tanks-2-11,000 gal-1-5700 Gal; Extruder 8" elec. heated; Ram extruder: Machinecraft Corp., 800 Wilson Ave., Newark, N. J. MI-2-7634.

FOR SALE—2200 Ton Birdsboro Heavy Duty Laminating Presses. Bed Size 7' by 5'. Each press contains two 25" diameter rams. Complete with Intensifiers for 4000 P.S.I. Stokes Model 294 Single Punch Tablet Press. Completely rebuilt with variable speed drive. Injection Molding Machines—1 oz. Van Dorn, 1½ oz. Leominster 2½ oz. Van Dorn, 4 oz. Moslo, 4 oz. Reed Prentice, 4 oz. Harvey, 8 oz. Reed Prentice, 12 oz. DeMattia, 12 oz. Reed Prentice, 16/20 oz. Reed Prentice. All in stock. Immediate delivery. Scrap Grinders, 1½ HP up to 50 HP available. 6" x 12" Erie Engineering Company Lab Mill. Variable speed drive. 6" Hartig Extruder, 16.5:1 Electrically Heated Barrel. Complete with all controls and motor drive. We have a full line of Laminating Presses, Molding Presses, Mills, Calenders, Extruders, Injection Molders, Scrap Grinders, Coating Equipment and other accessories for the Plastic Industry. We will finance. Johnson Machinery Company, 90 Elizabeth Avenue, Elizabeth, New Jersey, ELizabeth 5-2300.

FOR SALE - EXTRUDERS — 1½" JMC, Electric heated, 21/1 L/D 5HP U.S. Vari-Drive. 7½ HP U.S. Vari-drive. 3½" Royle, oil heated, extra screws. 1½" NRM, oil heated, plastic wire coating. Complete unit. Injection Machines—Reed-Prentice Model 10E-16. Moslo 4 oz. Universal, full automatic, Hydraulic Presses, tablet presses, pre-heaters, scrap cutters, etc. Hochman Plastics Machinery Corp., 151-P Mulberry St., Newark, N. J. MI 3-8430.

HIGH FREQUENCY HEAT GENERATORS—one thermex 7. K. W., 19.1 MC, grid size 14" x 20". One thermex 15 K. W., 13.7 MC, grid size 23" x 26". All units complete and for operation on 220 Volt, 60 Cycle, 3 phase. Good Condition. Standco Supply Co., 2701 Clinton Dr., Houston, Texas.

CHOICE EQUIPMENT Priced for Immediate Disposal. F-B Banbury Mixers Model #00, No. 11. F-B Unused 2 Roll Mills; 14" x 30" Uni-Drive F-B2 Roll Mills 18" x 54"; 22" x 60" F-B3 Roll Calender 22" x 60". Complete Hartig 4½" x 6" Electrically Heated Extruders. Vented, complete with drives. NRM 2½" Oil Heated Extruder with Vari-Speed Drive, and Cumberland Pelletizer. Welding Engrs. 2"/Twin S/S Screws; Oil Htd. Royle 2" Electr. Heated with Crosshead. NRM 1½" Jktd. with Crosshead; Vari-Drive. Davis Standard 3¼" Wire Insulation Set Up with Extruder, Crosshead, Capstan etc. Davis Standard 2" Wire set up, same as above. B. & J. Rotary Cutters, Lab. #1 and #2. 4 Stokes 150 Ton Self Contained Molding Presses, complete with all accessories. Other Presses from 7 Ton to 500 Ton. Preform Presses, Autoclaves, Ball Mills, New Ribbon Blenders, Centrifuges, Dryers. First Machinery Corp. 209-289 Tenth St. Bklyn. 14, N. Y. STerling 8-4672.

FOR SALE—HPM 200 oz. 1-1200 ton, 1-3000 ton; 400 oz. 3000 ton; 1955 at 30 percent of cost. Send for list 100 Injection, Compression, Extrusion machines throughout U.S.A. (Tel-DU 2-0640) Wanted—Plastic Mchy. for listing and selling. Fred C. Ziesenheim ME. 523 King Ave., Marion, Ohio.

HYDRAULIC PRESS—Link 50 Ton 4 Post 67" x 39" Bed Area. Up Acting Table 22½" Daylight, 12" Stroke. With 2 H. P. Pump and Tank. In good Condition. Price $2,000.00 F. O. B. Milford, Michigan—Robert H. Voigt P. O. Box 365—MUtual 4-0755.

WHEELABRATOR PLASTIC DEFLASHERS for sale: 15x20 Tumblast, 27x36 Tumblast and No. 1 Multi-table complete with dust collectors, control panels, p.b. stations. Guaranteed to be in like-new condition. Ideal for deflashing of plastic parts. Universal Machinery & Equipment Co., 1630 N. 9th St., Reading, Pa. FRanklin 3-5103.

FOR SALE—Ideal Lab Extruder 1½" NRM Complete with accessories. Price . . . open for offers Kessler Products Co., Inc., 4521 Lake Park Road, Youngstown, Ohio.

FOR SALE—(1)—Baldwin Southwark 150 ton self-contained compression molding press; (1)—Hartig 2" electrically heated plastics extruder; (2)—54 cu. ft. stainless steel double spiral ribbon blenders; (2)—Stokes model 741—50 ton automatic molding presses; (1)—Baker-Perkins 50 gallon jacketed double mixer, 50 HP. Chemical & Process Machinery Corp., 52 9th Street, Brooklyn 15, N. Y., HY 9-7200.

INJECTION MACHINES (2)—9 oz. HPM 1953, (1)—12 oz. REED 1953, (2) 4/6 REED 1955, Blowing Machines. (2) 2 Station Italian machines with extruders. All can be seen in operation—priced for quick sale. Valiant Plastics Corp. 106-10 Dunkirk Street, St. Albans 12, New York.

FOR SALE—500 ton W-S hobbing press. 500 ton Utility five 48"x30" platens. Four 300 ton Molding Presses various makes. HPM 200 ton downstroke. Watson Stillman 240 ton, ten 24"x56" platens. W & W 200 ton 24"x42". Strokes Standard 50, 100 and 150 ton semi-Automatics. D&B 150 ton, 25"x25". French Oil 120 ton self-contained. 120 ton upstroke, 29"x21". 50 ton Birdsboro 24"x20" Stokes 15 ton automatics. Hydraulic pumps and accumulators. MPM 3½" Wire covering Extruder. New ¾" plastic extruder. Other sizes to 6". Seco 6"x12" 2-Roll Mills and Calenders. Other sizes to 60". 60" Spreader Heads with XP motors. Despatch electric heated ovens and other types. New ¾ oz. Bench Model Injection Machines. Van Dorn 1 and 2 oz. Other sizes up to 100 oz. Baker-Perkins and Day jacketed Mixers. Taylor-Stiles Pelletizer, 7½ HP. Plastic Grinders. Stokes & Colton Preform Machines. Partial listings. Send for Bulletin #192. We buy your surplus machinery. Stein Equipment Company, 107-8th Street, Brooklyn 15, New York, STerling 8-1944.

FOR SALE—3½" Hartig Elec Extruder comp wire covering accessories, 6"x13" 2 Roll Lab Mill, 2-6" Elec Extruders, 50 Ton Watson Stillman 16"x13" Press self contained, 215 Cu. Ft. S/S Jact Blender, 1 Model R Scott Tester. Keith Machinery Corp., 73-15th Street, Brooklyn, N. Y. ST 8-5502.

PAPER PULP EQUIPMENT—Complete set up for manufacturing cellulose fibre parts including 3-Ft. Hydro-pulper, "00" Hydrofiner. Excellent equipment for pilot plant operation. Capable of producing moldings of strong kraft pulp. American Molded Fiberglas Co., P. O. Box #7, Carlstadt, N. J. N. Y. LA 4-3739 N. J. GE 8-0775.

FOR SALE—Baker-Perkins #16-UUEM, 150 gal. jacketed dispersion mixer, 150 HP XP drive, Vaulted cover; 100 gal. Baker Perkins T347SS jacketed dispersion blade mixer; Baker-Perkins 200 gal. jacketed sigma-blade mixers; 200 gal. and 500 gal. stainless jacketed reactors; 1350 gal. T347 stainless jacketed resin kettle; American 42" x 120" dbl. drum dryer, ASME code, stainless trim; 2600 gal. T316 stainless pressure tanks, coils, dished heads; 1800 gal. T316SS jacketed and agit. resin kettle; 800 sq. ft. T316SS shell and tube heat exchangers; Baker-Perkins #15-UUMM, 100 gal. jktd. dispersion blade mixer, 100 HP; Worthington 70 cu. ft. rotary blender; we pay cash—top dollar—for idle, surplus equipment. Perry, 1429 N. 6th St., Phila. 22, Pa.

FOR SALE—(3)—Thropp 2-Roll Mills 18" x 50", 6" x 12", 2" x 6", complete with motors; (2)—Cumberland #18 and #½ Granulators with motors; (3)—Baker Perkins 50, 100 and 150 gal. Sigma blade jacketed Mixers; (1)—P-K 1 cu. ft. 304 SS "V" Blender; (3)—Mikro Pulverizers, Bantam, 1SH and 1SI; (5)—Stokes Preform Presses, models R, T, DD2, DDS2 and D4; partial listing, send for details. Brill Equipment Company 35-55 Jabez St., Newark 5, N. J. Tel: MArket 3-7420.

FOR SALE—Model M420C Wink Universal Cutting Machine, Continuous or intermittent cutting. Motors 2 H. P. and 1/16 H.P. TEFC, 440-3-60, Model M226A Loop speed control unit. Hold down rolls, Hugger rolls. New in 1959. Reply Box 6946, Modern Plastics.

MOST MODERN PACKAGING AND PROCESSING MACHINERY—Available at Great Savings. Baker Perkins, W. & P. and Day Double Arm Steam Jacketed Heavy Duty Mixers—25, 50, 75, 100, 150 and 200 gal. capacities. Day, Robinson 50 to 10,000 lbs. Dry Powder Mixers, Jacketed and Unjacketed. Also wood and Enamel. H. K. Porter 650 gal. Steam Jacketed Double Spiral Mixers. B. P. 100 gal. Jacketed Stationary Vacuum Double Arm Mixer. Day Imperial 75 gal. Double Arm Mixer, Sigma, Dispersion Blades. Mikro Model 6, Stainless Steel Atomizer with Collector. Mikro Pulverizers, Models Bantam, 1SH, 2TH, 3TH and 4TH. Fitzpatrick Models D, K-7 and K-8 Stainless Steel Comminuters. Colton Models 241 and 260 Double Rotary High Speed Tablet Presses. Stainless Steel Jacketed Mixing Kettles 100 and 150 gal. capacities. Package Machinery, Hayssen, Scandia, Wrap King, Campbell, Miller Wrappers. Cartoning Machines—Ceco, Pneumatic Scale, Jones. Union Standard Equipment Company, 318 Lafayette Street, New York 12, N. Y. Phone: CAnal 6-5333.

Machinery Wanted

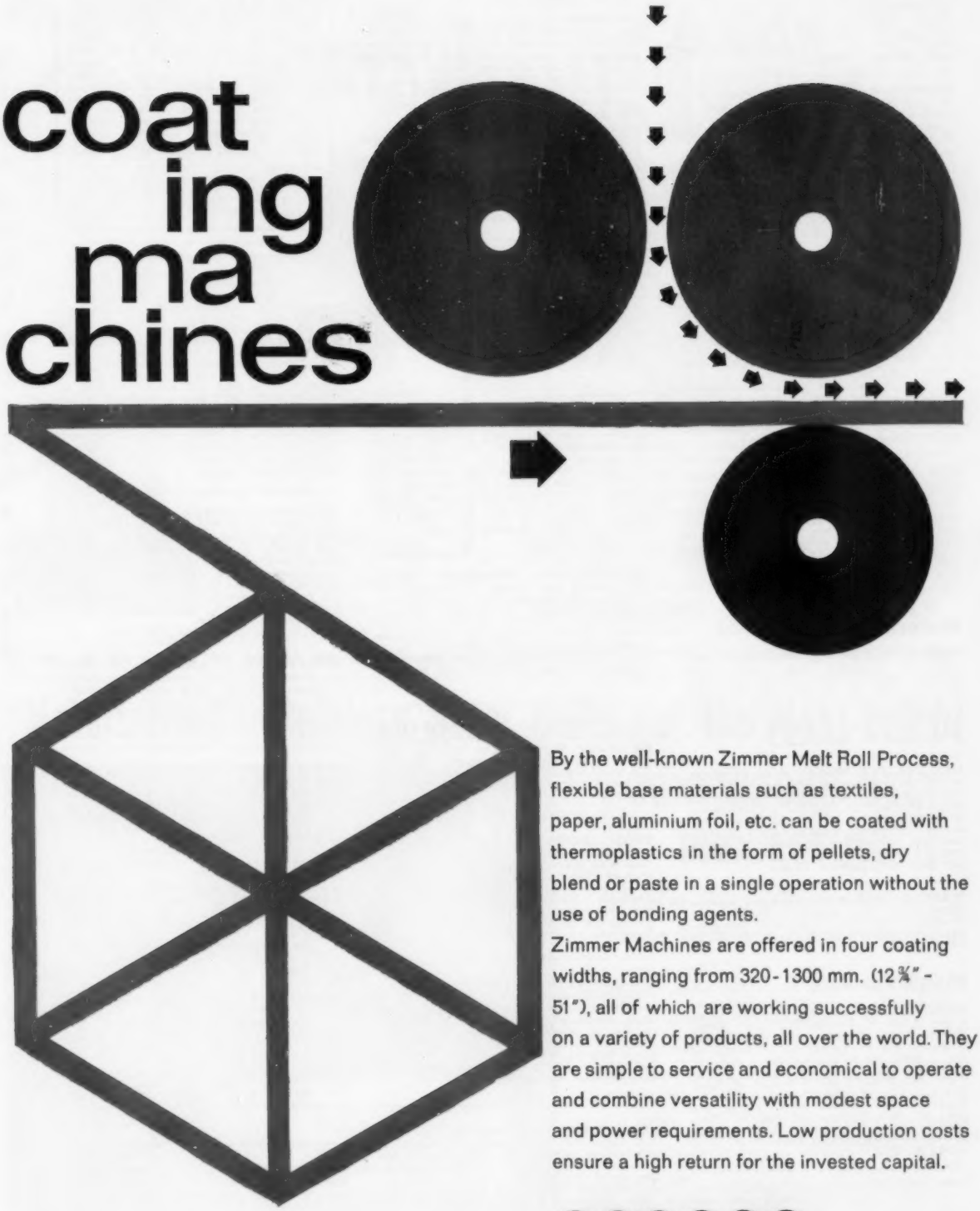
WANTED—AT ONCE—Three (3) Compression Presses 200 Tons and up—Also need preform machine have cash available for best deal. Will fly to see equipment, reply to: Midwest Plastics Corp. 451 North Water Wichita, Kansas. AM 2-1745 AM 2-5851.

TRIPLE AAA MANUFACTURER wants specifications and proposal on extruder and all necessary auxiliary equipment to extrude Geon HiTemperature, PVC, in tube form, and possibly Delrin and Nylon in rod form. Size range ⅛" to 1½" and alternate ⅛" to 3". Equipment to include stress relief. Reply to George Fiesler, Box 6923, Modern Plastics.

84" PRODUCTION MILL—Wanted For Plastics. Contact Mr. Bill Bodenstein, Rego Insulated Wire Corp., 830 Monroe St., Hoboken, N. J., WH 3-5793 (NY) OL 6-2020 (NJ).

(Continued on page 238)

coat ing ma chines



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Zimmer Machines are offered in four coating widths, ranging from 320-1300 mm. (12¾" - 51"), all of which are working successfully on a variety of products, all over the world. They are simple to service and economical to operate and combine versatility with modest space and power requirements. Low production costs ensure a high return for the invested capital.

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(Continued from page 236)

WANTED—2½ to 3½ inch electric extruder with sheet take off, or will buy components separately. Also want sheet former and trimming press. Reply Box 6951, Modern Plastics.

WANTED—Baker-Perkins (or equivalent) 50 gallon working capacity, size 14, double arm mixer. Dispersion or sigma blades. 25 H.P., 440 volt, 60 cycle motor. Reply Box 6940, Modern Plastics.

WANTED—BLOW MOLDING MACHINES—Used blow molding machines—preferably rising table type. Also 2½" or 3½" Extruder with accumulator. Reply Box 6952, Modern Plastics.

Materials For Sale

FOR SALE—2,000 lbs. Black B. F. Goodrich flexible Vinyl Film, mat finish one side, polished surface other side. .007" x 46" x 1,000 ft. rolls. 4,000 lbs. same material .010" x 44" x 1200 ft. rolls. Cost 54¢/lb; will sell for 20¢/lb. fob. West American Rubber Co., 410 N. Ave. 19, Los Angeles 31, Calif.

FOR SALE—Chopped Fiberglas, ⅞" roving. Cleaned and packaged as per your requirement. Plastiwall, Inc., 2300 McKinley Avenue, Fort Wayne, Indiana.

FOR SALE-BELOW MARKET. Ethyl Cellulose Reground Natural. Isobutyl Methacrylate Polymer. Red, Yellow, and Green Aniline Colors. Cobalt & Zinc Stearates. Indopol-Polybutene H100. Dimethyl Phthalate 90%. Zinc Oxide #12 Pellets. P. V. Acetate 50% Solution. Stabilizer SN. Vanstay L. Silicone Oil 350 ctks. Other Items. Send Inquiries. Chemical Service Corp., 84 Beaver Street, NYC 5.

Materials Wanted

PLASTIC SCRAP WANTED—Clear acetate and butyrate sheet scrap, cast acrylic, acrylic molding powder, styrenes, polyethylene, etc. We pay top dollar for your plastic scrap and surplus molding powders. Write, Wire or Phone Collect—TL 3-3111—Philip Shuman & Sons, Inc., 571 Howard St., Buffalo, N. Y.

GET THE TOP MONEY FOR PLASTIC SCRAP—Now paying top prices for all thermoplastic scrap. Wanted: polystyrene cellulose, acetate, vinyl, polyethylene, butyrate, acrylic nylon. All types and forms including rejects and obsolete molding powders. Fast action wherever you are located. Write, Wire, Today! Reply Box 6930, Modern Plastics.

WANTED—Acetate, Butyrate and Styrene Sheet Scrap. Any Quantity: Sheet Trim, Purgings, Reground. Claude P. Bamberger, Inc., Ridgefield Park, N. J., HUbbard 9-5330.

Molds For Sale

INJECTION MOLDS—For Polyethylyene. 4 cav. 4 ass. 6" Trucks. 2 cav. 8" Dump Truck. 6 cav. 2 compl. 10" Tow Truck. 2 molds for 7" Caterpillar Tractor. 13 cav. 1 complete 11" Helicopter. 2 cav. 13" Platform Trailer. 96 cav. Poppit Beads. For Polystyrene: 4 cav. 2 compl. 6" Farm Tractor. 12 cav. Pocket Comb. 24 cav. Pocket Comb. 6 cav. Men's comb. 144 cav. 16" Ball Button. 128 cav. 20" Ball Button. Molds in exc. cond. & low priced. Alfred A. Rosenthal, 3 Park Row, New York, N. Y.

FOR SALE—School supply molds, housewares molds also some novelty and specialty items. All molds in excellent condition. Reasonable prices. List furnished upon request. Sterling Plastics Co., 1140 Commerce Ave., Union, N. J.

Molds Wanted

MOLDS WANTED for houseware and toy items. Please state mold size, cavities and products. Also type material and asking price, etc. Reply Box 6950, Modern Plastics.

Help Wanted

ENGINEER—Immediate opening for one that has experience in the operation of bilaterally oriented film to take charge and assume responsibility for processing a good quality oriented plastic film by the tendering method. Replies held in confidence. Send resume including salary requirements. Address Box 6926, Modern Plastics.

CHEMIST—Experienced phenolic resin field. Internationally known company, metropolitan New Jersey. Salary commensurate with experience. Our employees know of this ad. Send resume to: Box 6927, Modern Plastics.

VACUUM METALIZING—Situation open for man to take complete charge of vacuum metalizing operation in long established firm. Must have complete production and operational knowledge of vacuum plating processes. Plant location in Boston Area. Excellent program of company benefits. Reply submitting resume and salary requirements to: Box 6929, Modern Plastics.

PLASTIC ENGINEER—Exceptional opportunity for young engineer (age 25-30) to grow with expanding plastic's industry. The employee we seek will work mainly in the area of manufacturing processing, machine and die maintenance. Liberal fringe benefits. Submit complete resume of experience, stating age, education, marital status and salary requirements. Replies are strictly confidential. Reply Box 6922, Modern Plastics.

POLYETHYLENE SPECIALIST desired for product and market development in various applications. Prior experience in production, sales, research and development helpful. Location: Western Pennsylvania. Please submit in confidence resume and salary requirements to: Manager Product Development Laboratory, Koppers Co., Inc., P. O. Box 65, Monaca, Pa.

MANUFACTURERS REPRESENTATIVE—Wanted for sales of Thermoforming, expandable Styrene. Die Cutting and Blister Packaging Equipment. Opening for experienced men. Send complete information to Box No. 6948, Modern Plastics.

TOOL DESIGNER—Well established growing proprietary molder is seeking man with approximately 10 years experience in injection mold design. Knowledge of modern injection molding machines desirable. Excellent opportunity. Send complete resume including salary requirements to Sterling Plastics Co., 1140 Commerce Avenue, Union, New Jersey.

SUPERINTENDENT OR GENERAL FOREMEN—wanted by modern, progressive Mexican injection molding and blow molding plant. Will be in full charge of operations, maintenance etc. Some knowledge of mold making procedures helpful. Write in confidence, giving full details. David H. Rosenstock, P. O. Box 78, East Rutherford, N. J.

PLASTIC ENGINEER—manage Engineering Dept. of Established NY concern. Must have proven record on managing personnel. Experience in Thermo-plastics mold design and product engineering required. Mechanical Engineering degree preferred. Send resume Box MP 1246, 125 W. 41 St., NY 36, NY.

CHEMIST Plastic Processing Opportunity for top management position. Salary open & liberal benefits. Vinyl processing manufacturer seeks man with experience in both virgin and reprocessed P.V.C. Will run compounding plant from both chemical, quality control and production aspects. Rego Insulated Wire Corp., 830 Monroe St., Hoboken, N. J. OL 6-2020.

FIBER GLASS RESEARCH—Position available for organic chemist with Ph. D. or equivalent experience for long range program on woven fiberglas. Improved resin-to-glass bond in reinforced plastics, new fabric applications and improved finishes for fabrics are among the objectives. Applicants should be capable of independent and creative applied research and development, on a broader than normal basis. Excellent opportunity in rapidly expanding laboratory in Northern New Jersey. Best suburban living area plus excellent schools. Send resume in confidence to Director, Central Research Laboratory, J. P. Stevens & Co., Inc., 141 Lanza Avenue, Garfield, New Jersey.

PRODUCTION SUPERVISOR — Plastic Molding Plant. We are seeking a graduate engineer with 5-10 years of plastic manufacturing experience to accept a challenging position with a medium sized, well established plastic molding plant. Successful applicant should have a thorough knowledge of injection molding presses and the various plastic materials, personnel, costs and estimating and the ability to secure and maintain production. This man will report directly to the Plant Manager. Age preference 30-40. Salary based on experience and potential. Liberal fringe benefits. Submit complete resume of experience, stating age, marital status and salary requirements. Reolies strictly confidential. Reply Box 6921, Modern Plastics.

PLASTICS ENGINEER—Graduate Engineer, Age 28-38, Experience in Injection and Compression Molding. Some Foam and Plastic Tooling experience helpful. Established company in Eastern state has position open for development of new products, process improvement and quality control. Liberal benefits. Give complete resume and salary desired. Box 6943, Modern Plastics.

WANTED—Young salesman with some experience in either injection or compression molding. Need good idea man. Plant situated in Metropolitan New York vicinity. Salary plus commission. Write Box 6928, Modern Plastics.

PLASTICS ENGINEER—with considerable experience in Vinyl Extrusions including Rigids and Die Design, as Production Manager of new Extrusion Unit of long established firm. Unique products. Long Island location. Reply Box 6942, Modern Plastics.

MANUFACTURER'S REPRESENTATIVES WANTED—Leading custom molder of Foam Polystyrene has sales territories available in midwest and south. State qualifications, other lines, and territory covered. Reply Box 6939, Modern Plastics.

PRODUCTION MANAGER — Reinforced Plastics. Exceptional opportunity available for graduate engineer age 30-40, experienced in the production of reinforced plastic panels. Will be responsible for continuous process fiber glass sheet operation. Should be familiar with plant and process design. Southern location. All replies held confidential. Submit complete resumes to: Box 6941, Modern Plastics.

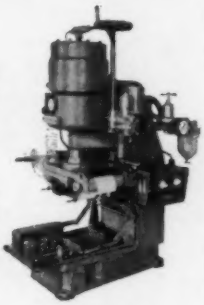
PROJECT ENGINEER. An established Midwest manufacturer of building products needs an engineer experienced in the application of fibre glass or foam for a new product. This will diversify a line that has national volume and acceptance in other materials. The work requires a technical education, experience, and ability to work with others to accomplish, design, processing, production and sales. Commensurate salary, benefits, and responsibility provides an opportunity with a progressive, stable company. Please send details in complete confidence to: Box No. 6938, Modern Plastics.

(Continued on page 240)

ACROMARK® YOUR PLASTICS PRODUCTS with ACROLEAF MACHINES and FOIL

ACROLEAF® MODEL 250H

Hot Stamping Machines used with ACROLEAF® foil, actually "fuse" the plastic color pigment with the plastic product thereby making a permanent, sharply attractive mark or decoration.



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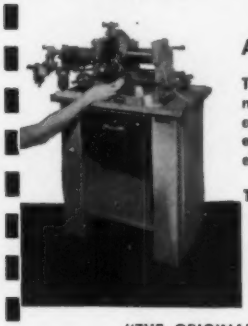

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This is "the original" hot stamping machine for peripheral marking. Unequalled for fine work and fast operation, semi or fully automatic with electronic controls.

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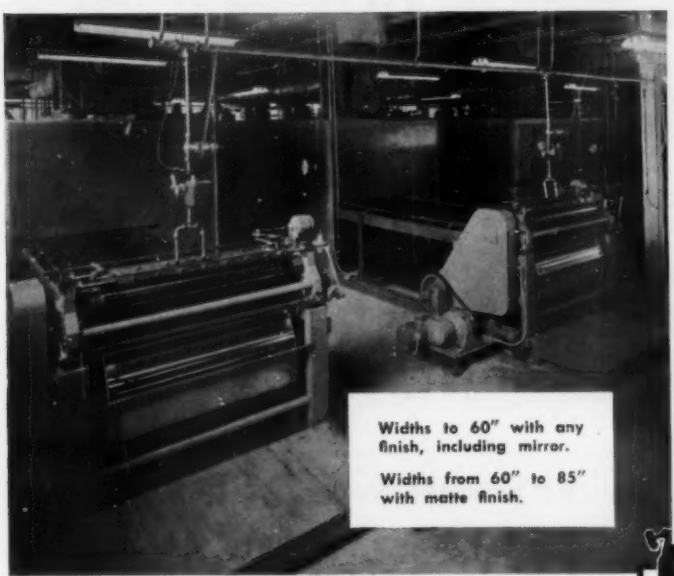

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Much of the success of continuous belt processing depends on the belt itself! Metalsmiths' engineers have made great advances in the art of fabricating stainless steel belts. For example:

Metalsmiths endless stainless steel belts are available in widths up to 85", permitting processing of larger areas. Made of 18-8 stainless steel, they are corrosion-resistant, wear-resistant, easy to keep clean.

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Consult our engineers on the possibilities for your products, without obligation.

METALSMITHS 558 White Street Orange, N. J.
Specialists on Stainless Steel Fabrication.

METALSMITHS
STAINLESS STEEL
ENDLESS CONVEYOR BELTS

(Continued from page 238)

MANUFACTURERS REPRESENTATIVE—Immediate opening for ambitious rep. to establish distributors for expanded polystyrene boards, primarily interested in construction market. Areas open in Upper Midwest outside of Minnesota. Excellent opportunity with expanding organization. Send full details including area covered to Wood Fab Inc., Lester Prairie, Minnesota.

INJECTION MOLDING MAN wanted with thorough experience in nylon, delrin, vinyl etc. Capable handling job from start to finish. Metropolitan New York vicinity. Write box 6933, Modern Plastics.

WANTED—Young Man for Plastics Sales. In packaging field, New York office. Good opportunity. College graduate preferred. Salary, bonus, expenses paid. Send resume experience and education. Replies confidential. Write Box Number 6935, Modern Plastics.

WANTED—FOR SALES ENGINEERING POSITIONS, men with experience in Extrusion Coating, Paper Converting, Plastics Extrusion. Please send resume and salary requirement to: Mr. W. C. Haulenbeck, Frank W. Egan & Company, South Adamsville Road, Somerville, New Jersey.

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INCREASED DEMAND FOR nationally-advertised line of Plastic Thermoforming, Expandable Styrene, Die Cutting and Blister Packaging equipment has created an outstanding opportunity for a manufacturer's representative. Excellent product acceptance, favorable price advantage. Write fully to: Box Number 6925, Modern Plastics.

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Situations Wanted

MANAGEMENT — Chemical Engineer. Eighteen years proven accomplishments as plant manager, assistant plant manager, plant superintendent, production superintendent, head quality control, head engineering department. Experienced chemicals, fats and oils, foods, monomeric and polymeric plasticizers-esters, fatty acids, alcohols, sulfuric acid, adhesives, vitamins, dry-wet millings. Reply Box 6894, Modern Plastics.

EXPERT on the use of plastics in agriculture. 36-year-old developmental agronomist with broad experience in the agricultural chemical field and with national contacts throughout the fertilizer industry desires development or sales management position. Resume upon request. Box 6920, Modern Plastics.

ATTENTION MANUFACTURERS — I want to sell in the Southeastern States. Marketing and management background includes: thermoplastics, thermosets, and extensive FRP experience. Ability to do an aggressive, conscientious, organized sales job. Reply Box 6949, Modern Plastics.

MANUFACTURERS AGENT desires additional line allied to rubber and plastic industry. Now covering Ohio, soon to go into Michigan with line of mold lubricants and release agents. Reply Box 6936, Modern Plastics.

SALESMAN—now covering New England and New York State for compression molder heavy on Teflon and reinforced materials. Present association too limiting. I am looking for a house doing compression, transfer, and possibly injection work with an aggressive approach to growth. Box 6937, Modern Plastics.

URETHANE FOAM APPLICATIONS CHEMIST—Specialist in one shot flexible foams. Wide range of formulation know-how. Many years of successful research and development. Supervisory and production experience. Knowledge of machinery. Seeks challenging and responsible position in new product development. Reply Box 6947, Modern Plastics.

PLASTIC DECORATOR — Cylinder pressman and die cutting. Rigid plastic films, light and heavy gauge fields. Background in ink technology and plastic fabrication. Reply Box 6945, Modern Plastics.

COLORIST — Extensive experience in plastic field. Seeks position with progressive firm. Reply Box 6944, Modern Plastics.

Business Opportunities

LEADING COMPANY interested in entering plastics field. Would manufacture toys, household goods and other plastic articles—either injection molding or rotational cast plastisol—for distribution in Latin America. Interested in contacting owners of dies and molds not currently in use who will be willing to go into foreing production. Profits easily taken out of country in dollars. Low labor costs would make this an extremely profitable enterprise. Reply in detail to Box No. 6931, Modern Plastics.

WELL-KNOWN BRITISH FIRM forming part of large engineering group and producing substantial quantities of Phenolic Laminates, Flexible Insulation, Plastics and Rubber products, is seeking lines for expansion where specialized knowhow, patents or capital can restrict competition. The company has adequate technical and financial resources to manufacture and sell in Britain, Europe and the Commonwealth countries. A meeting with any patentee or manufacturer with lines capable of development in these territories would be welcome. Reply Box 6890, Modern Plastics.

FOR SALE — Complete Silver Nitrate Metalizing Plant. Capable of volume plating production. Includes two Genrich walk-in ovens, laquer tanks, silvering booths, Penfield De-Mineralizer, etc. Reply Box 6924, Modern Plastics.

MANUFACTURER'S AGENT covering two hundred mile area around Pittsburgh, Pa. wants Toy, Sporting Goods, or Houseware Lines. Write Fred Marsh, Post Office Box #10552, Pittsburgh, Pa.

FOR SALE—Plastic Compounding & Reprocessing Plant located in California —modern equipment—good reputation in trade—excellent purchase & sales contacts—business can be expanded—owner will remain if desired. Reply Box 6954, Modern Plastics.

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PLASTICS COMPOUNDING PLANT WANTED—Well known Eastern Firm with good raw material position requires Mid-West location for better customer service. Cash available for outright purchase with option for present management to remain or would consider merger. Write Box No. 6932, Modern Plastics.

Miscellaneous

BLOW-MOULDING — The following companies announce that they are now licensed under Kautex Patent No. 744,927: Casceiloid (Division of The British Xylonite Co. Ltd.) Lacrinoid Products Limited, and the Metal Box Company Ltd.

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QUICK SAMPLE MOLD SERVICE WANTED — Major manufacturing concern needs quick sample mold service for closures and custom molded containers. Require part drawings and samples from sketches and models in maximum of five days. No connection with molder permitted. Ideal opportunity for mold maker with test molding equipment available. Both injection and compression. Greater New York area location a must. Box No. 6919, Modern Plastics.

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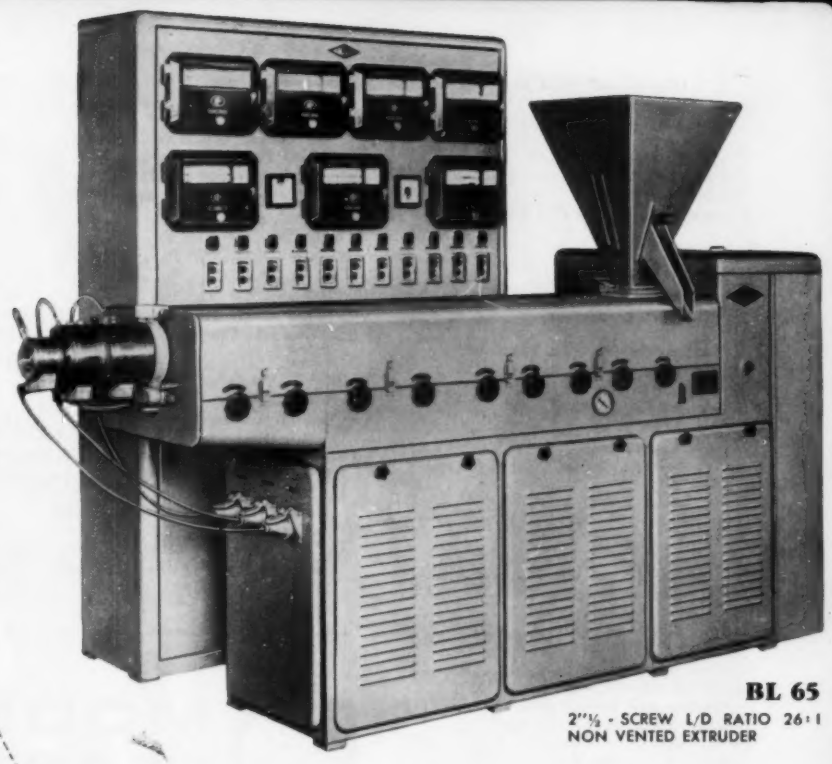

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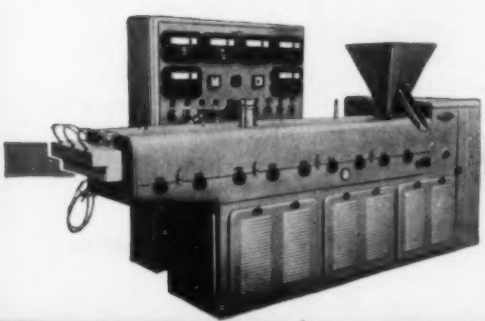

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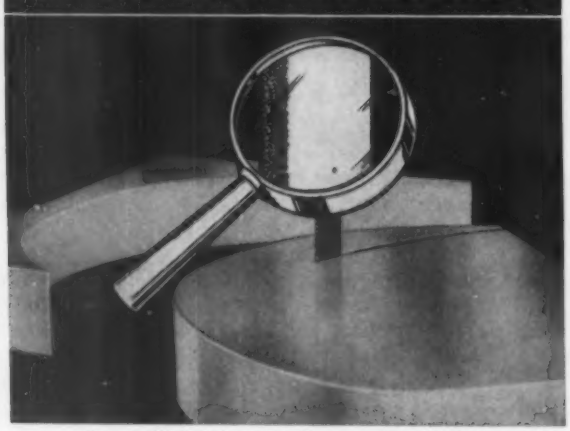

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Iodine Value	5 Max.
Gardner Color	Less than 1
Gardner Viscosity @ 25°C	V Max. (6.8 poises)
Saponification No.	176 Max.
Acid No.	0.3 Max.
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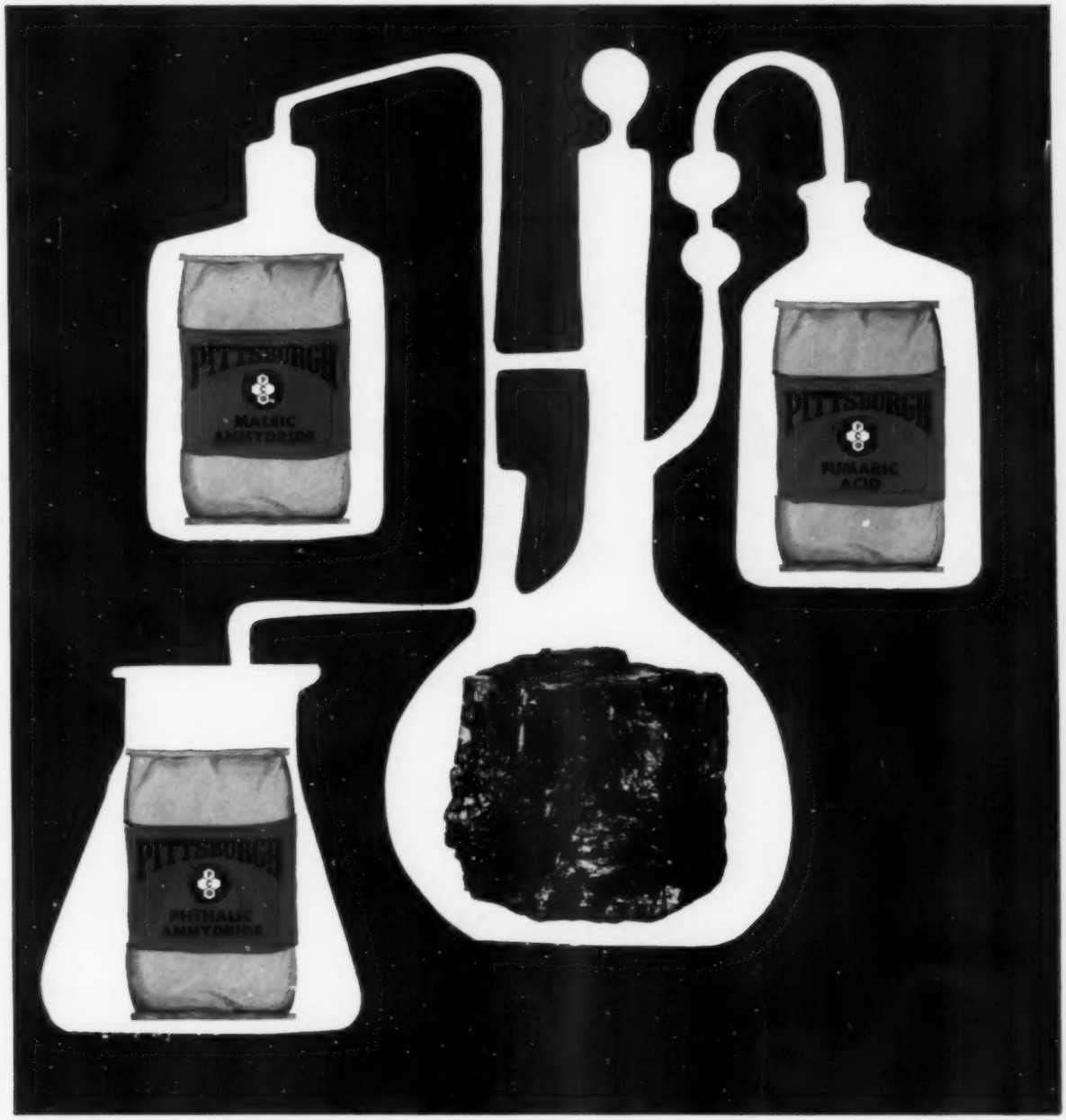

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"LEXAN resin is the only material we have approved for our diffusers," says Gordon Sylvester, Chief Product Engineer of Carnes. "We tried polystyrenes, polyethylene, nylon and others, but they all fell short in one way or another."

The material for Carnes' diffusers had to meet this combination of requirements: • INJECTION MOLDING for low production cost. LEXAN resin, as a thermoplastic, gave this advantage. • NO HEAT DISTORTION in 225°F. test for handling warm air. In month-long tests of parts, LEXAN resin met this spec. Actually, the resin's rated distortion point is 270-280°F. under load. • DIMENSIONAL STABILITY in use. LEXAN resin was stable. • FLAME RETARDANCE to pass ASTM test. LEXAN resin passed. • COLOR STABILITY and versatility. Although the modules are now a stable white, LEXAN resin offers the possibility of a wide range of colors. • HIGH IMPACT RESISTANCE. Frank Freese, Product and Merchandising Manager for Carnes, really sells LEXAN resin's enormous impact strength. He says "In demonstrating the strength of the modules, we slam them against the wall. It doesn't damage them at all. Metal diffusers would be bent by this treatment."

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